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PROCEEDINGS

OF THE

GENERAL MEETINGS FOR SCIENTIFIC BUSINESS

OF THE

ZOOLOGICAL SOCIETY

OF LONDON.

1904, vol. II.

(MAY—DECEMBER.)

PRINTED FOR THE SOCIETY,
AND SOLD AT THEIR HOUSE IN HANOVER-SQUARE.

LONDON:
MESSRS. LONGMANS, GREEN, AND CO.
PATERNOSTER ROW.

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1904.



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PROCEEDINGS
OF THE
GENERAL MEETINGS FOR SCIENTIFIC BUSINESS
OF THE
ZOOLOGICAL SOCIETY OF LONDON.

1904, Vol. II. (May to December).



May 3, 1904.

G. A. BOULENGER, Esq., F.R.S., Vice-President,
in the Chair.

The Secretary exhibited, on behalf of Dr. Graham Renshaw, F.Z.S., an outline-drawing of a young African Elephant showing an unusual development of the hairy covering of the body. Dr. Renshaw had supplied the following notes on the specimen in question :—"The Elephant was a small calf presented by M. Verreaux to the Jardin des Plantes Museum, Paris, the locality being somewhat loosely given as 'the Cape of Good Hope.' No date appeared on the label, but as a skeleton of a female *Rhinoceros simus* (mounted in the adjoining gallery of Comparative Anatomy) was labelled 'Ed. Verreaux, 1846,' perhaps it might be assumed that the Elephant was also presented about that date. In any case, it had evidently been in the collection for very many years. The hairy covering showed a remarkable development in many parts of the body. In this specimen the tusks had not begun to appear at the time of death. It would be very interesting to ascertain if these abnormally hairy individuals tend to lose this covering with advancing years. Similar instances have been noted in the Indian species, and brought to the notice of the Zoological Society. Thus, I understand that a photograph of a mother and calf, taken in Ceylon and showing considerable development of hair, was exhibited at a former meeting of the Society; that attention was also drawn to an individual (sold in 1882) which

lived in the Gardens and was remarkable for the hair along its back and on its head; and that the National Collection contains a young calf, remarkably hairy, born in the Regent's Park collection in 1903. All these seem to be referable to the Indian Elephant, so that, as the first recorded instance of the same phenomenon in the African species, this note may be of interest."

The Secretary also exhibited a photograph, presented to the Society by Mr. Frank Haes, of the female specimen of the Quagga which had lived in the Society's Gardens.

Mr. F. E. Beddard, F.R.S., exhibited the brain of a Troupial (*Quiscalus versicolor*) in the hinder part of both cerebral hemispheres of which was an entangled mass of Nematoid worms lying below the pia mater. The bird was reported to have dropped down suddenly from its perch "in a fit."

Mr. R. H. Burne, F.Z.S., on behalf of Professor Stewart, exhibited and made remarks upon specimens of the female reproductive organs of the Marsupials *Perameles obesula*, *Trichosurus vulpecula* (one specimen from a virgin in which the septum between the median vagina was still intact, and another from an individual that had borne young, in which the septum was absorbed), and *Dasyurus viverrinus*, during pregnancy, showing the increased size of the uteri, due mainly to enormous thickening of the mucosa. These specimens had been presented to the Royal College of Surgeons by Mr. James P. Hill, of Sydney University.

Mr. Burne also exhibited photographs of a Leathery Turtle (*Dermochelys coriacea*), lately purchased by the Royal College of Surgeons. The individual, which came from Japan, was a female, measuring 4 ft. 4 in. in length.

The following papers were read:—

1. On the Osteology and Systematic Position of the rare Malagasy Bat *Myzopoda aurita*. By OLDFIELD THOMAS, F.R.S., F.Z.S.

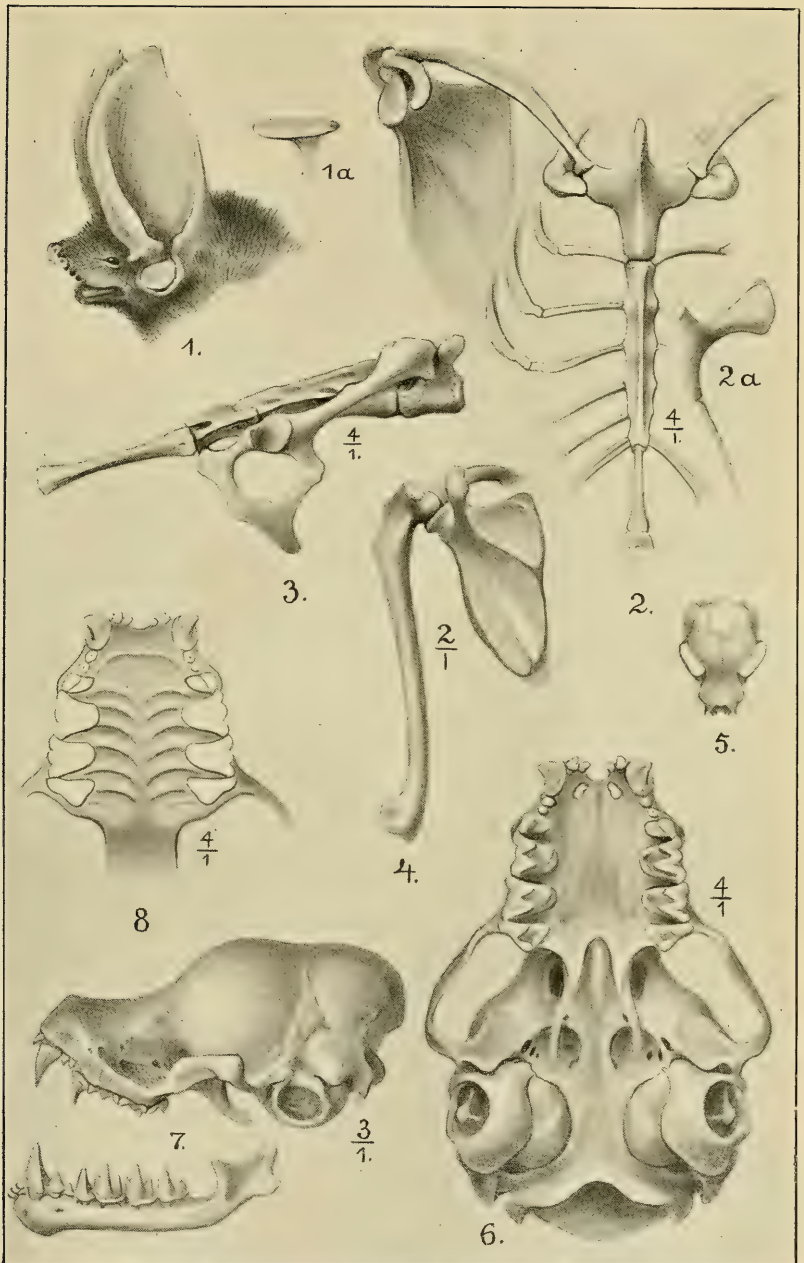
[Received April 9, 1904.]

(Plate I.*)

In 1899 the British Museum was fortunately able to acquire a specimen of the exceedingly rare and remarkable Bat *Myzopoda aurita*, which had been obtained at Tamatave, Madagascar, by Dr. Tchébaud.

This animal was first described by Milne-Edwards and Grandi-

* For explanation of the Plate, see p. 6.



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dier in 1878*, and further descriptions of the type specimen were given by Dr. Dobson†, but in neither case was there any account of the skull or skeleton, nor were any figures published to illustrate its many peculiarities. It is therefore thought that some figures of the animal, with an account of its osteological characters, will be of service to students of the Chiroptera.

Of the external characters little further notice is necessary beyond drawing attention to the figures given (Pl. I.) of the ear (fig. 1) and of the peculiar mushroom-shaped process (fig. 1 a) at its outer base, an organ unknown in other Bats.

I would, however, express my opinion that the "irregularly square lobe in the usual position of the tragus or slightly in front of it, continuous above with the keel of the ear-conch" (Dobson), does actually represent the tragus of other Bats, coalesced in this case with the inner base of the ear, an arrangement unique within the Order.

The penis is short, slender, pointed, and without a bone; the glans very slender, stylistiform, about 2 mm. in length, the opening of the urethra at its base above; the prepuce wrinkled and quite naked externally, a very unusual character.

The palate has a single undivided ridge, convex forwards, running across between the anterior premolars, and six pairs of divided ridges between the larger cheek-teeth (see Pl. I. fig. 8).

The skull is short, broad, smooth, and rounded, in a superficial view not unlike that of a *Chilonycteris*, though shorter-muzzled. The brain-case is proportionally large, smooth, spherical, unridged, not abnormally raised above the face-line. Nasal notch shallow, quite unlike the deep notch characteristic of the *Vespertilionidæ*; but, unfortunately, the specimen is too old to show the nasal and other sutures, so that the exact disposition of the bones cannot be described. Premaxillæ united between and in front of the rather irregular palatine foramina, but not bearing teeth in the middle line; their structure and that of the anterior nares very similar to what is found in *Natalus*. Posterior nares low from above downwards, much obstructed by the large rounded keel of the vomer, which is ankylosed to the palatine in the middle line; opening of nares narrowly U-shaped, the front edge of the opening level with the front of m.³ Pterygoids narrow, divergent, ending in long, curved, hamular processes. Two large circular basi-sphenoid pits present, one on each side between the antero-internal corner of the bulla and the back of the pterygoids; their dividing septum T-shaped in section, its buccal surface broad, smooth, and in level continuation with the mesopterygoid fossa and the basioccipital, but narrowed upwards, where the floors of the two pits approach each other closely. Bullæ and cochleæ of medium dimensions. Basioccipital smooth and broad, quite filling up the space between the bullæ.

* Bull. Soc. Philom. 1878, p. 220.

† P. Z. S. 1878, p. 371. Report on accessions to Chiroptera during 1878-1880, p. 23: British Association Reports, 1880.

Teeth of the normal insectivorous structure; the reduction in size of the incisors, two anterior upper and median lower pre-molars as in *Myotis*, though the resemblance is clearly quite superficial.

Dimensions of the skull:—

Greatest length 16 mm.; upper length in middle line 14·4; basal length 13·5; zygomatic breadth 11·8; intertemporal constriction 4; breadth of brain-case 9·6; palate, length 5·8, breadth inside m.² 3, outside m.² 6·4; front of upper canine to back of m.³ 6·3; front of lower canine to back of m.₃ 6·7.

The skeleton as a whole, including the structure of the sternum and pelvis, appears to be remarkably like that of certain Vespertilionide, notably *Scotophilus*; but I suppose this to be due to its being of a primitive nature, without any noteworthy specialisations in the way of ankyloses or hypertrophy of parts. Wonderful differences are to be found in these respects in various genera of Chiroptera*, but I have not studied the subject sufficiently to form an opinion as to the systematic value to be attached to these modifications. Fortunately, Mr. Gerrit Miller is now engaged on a general revision of the classification of Bats, and is dealing fully with the skeletons, so that I do not propose to do more than give a short description of that of *Myzopoda* for incorporation in his work.

The vertebral formula is C. 7, D. 13, L. 5, S. 4, C. 8; total 37, *plus* a cartilaginous rudiment of a ninth caudal vertebra. None of the vertebræ are ankylosed together, except of course those of the sacrum, thus widely differing from the condition in *Natalus*. Eight of the ribs are connected with the sternum by costal cartilages, the ninth, tenth, and eleventh also having cartilaginous continuations not reaching to the sternum; the twelfth and thirteenth are practically without such continuations.

The sternum is simple and little specialised; the presternum normal, with a rather elongate manubrial process (fig. 2*a*), which is but little expanded terminally; the broad sterno-costal plate† between the presternum and first rib, so characteristic of Bats, of average dimensions; mesosternum slender, 6 mm. in length, slightly keeled, the costal cartilages of the 3rd to the 7th ribs articulating with its sides at subequal distances, that of the 8th joining it side by side with that of the 7th at its posterior end; xiphisternum 2·8 mm. long, slender, scarcely broadened terminally. Proportions of scapula as shown in the Plate (figs. 2 & 4), its antero-internal angle produced into a well-marked process projecting downwards and inwards towards the vertebral column. Coracoid about 3 mm. in length, therefore not long for a Bat of this size, simple, slightly falciform, not expanded terminally.

The pelvis is on the whole very similar to that of *Scotophilus*

* The peculiarly ankylosed vertebral column of *Natalus* and the highly modified sternum of *Kerivoula* are examples.

† The homologies and proper name of this bone are not as yet definitely settled. It is the "7" of Winge's figure on p. 44 of his Chiroptera of Lagoa Santa (E Mus. Lundii, 1892), where its relation to the epicoracoid of Parker is discussed.

temminckii in its proportions and the angle at which it is set. It is even less expanded across the ilia, which are rounded instead of being concave above. Its length, dorsally, is 9 mm.; its breadth at the acetabulum 5·4, and in front across the ilia 3·8; its depth from front to back 4·6. The symphysis is more slender, though still firmly ossified, and the obturator foramen is smaller. The pectineal process is unusually slightly developed, far less than in any Bat that I have had the opportunity of examining, and is indeed hardly to be called a process.

In its entirety, therefore, the skeleton of *Myzopoda* is remarkable for the simplicity and non-specialisation of the different parts. In all other Bats' skeletons that I have examined (not, I confess, a very large number, but still representing most of the groups) there are some specialisations, such as unusual ankyloses or peculiar development and expansions of processes, but in *Myzopoda* none of these are present, while even normal Chiropterous characters, such as the elongation of the coracoid and the pectineal process on the pelvis, are at a minimum.

It will be evident from the above description, from those of Milne-Edwards, Grandidier, and Dobson, and from the figures now published, that *Myzopoda* is a most remarkable and peculiar kind of Bat, and that it must certainly form a special Family, the *Myzopodidæ*, though the affinities of this Family are by no means clear. Both Milne-Edwards and Dobson referred *Myzopoda* to the Vespertilionidæ, forming of it a group equivalent in value to the *Plecoti*, *Vespertiliones*, and *Miniopteri*. Now, however, that Mr. Miller has taken *Natalus* and *Thyroptera* out of the Vespertilionidæ*, the chief reason for leaving it in that Family has been removed, for it is only to those genera that *Myzopoda* could be supposed to be related.

On the whole, it appears to me probable that *Myzopoda* is most nearly related to the Natalidæ and Mormoopidæ†, being a descendant—specialised in some characters and primitive in others—of the common ancestors of those groups. The occurrence of sucking-disks both in *Myzopoda* and *Thyroptera* is no doubt a coincidence, for these organs would appear to be comparatively recent specialisations. On the other hand, the possession of three phalanges in the middle finger in the same two genera is presumably a primitive character, for both Phyllostomatidæ and Mormoopidæ possess three, and the loss of the third one in *Natalus* and *Furipterus* of the Natalidæ‡ is one of the characters in which that Family shows an approach to the still more highly-developed Vespertilionidæ.

* "History and Characters of the Family Natalidæ," Am. Nat. xii. p. 245 (1899).

† As has already been done by various other authors, I would regard the "*Lobostominae*" of Dobson as forming a Family distinct from the Phyllostomatidæ.

‡ Mr. Miller states that the long terminal phalanx of the two-phalanged *Natalus* and *Furipterus* "is divided into two in *Thyroptera*," but without very definite embryological evidence it would be difficult to accept this homologisation. The terminal bar of cartilage beyond the second phalanx in the Vespertilionidæ is a hint at a different homology, and one more in accordance with the usual ideas on the subject.

The interest of the relationship of this Madagascar Bat to purely American groups is obvious, as adding one more to the forms of that island which show the same affinity.

But the alliance of the Myzopodidæ to either the Natalidæ or the Mormoopidæ is by no means close, and there can be no question that the Family is quite a distinct one. As a diagnostic point, the coalescence of the tragus with the ear-conch is noteworthy, for almost every Family of Chiroptera can be diagnosed by the development and structure of this organ, and its unique condition in *Myzopoda* is an index to the special peculiarity of the group.

Still more interesting will it be, as bearing on the question of a southern connection between the faunas of the Old and New Worlds, if the New Zealand *Mystacops* should prove to be a member of the same series of forms. Its three-jointed middle finger and the general structure of its skull and dentition point in this direction, while its exserted tail and warty lower lip suggest the Mormoopidæ quite as much as the Emballonuridæ, to which it has been usually referred. Pending the publication of Mr. Miller's researches on the classification of Bats, however, I do not wish to do more than suggest a possibility that *Mystacops*, like *Myzopoda*, may prove to have American affinities.

EXPLANATION OF PLATE I.

Myzopoda aurita.

- Fig. 1. Side view of head. $\frac{1}{4}$.
 1a. Mushroom-shaped process of ear, enlarged.
 2. Sternum and scapula. $\frac{1}{4}$.
 2a. Side view of manubrial process of presternum.
 3. Pelvis. $\frac{1}{4}$.
 4. Scapula and humerus from behind. $\frac{2}{3}$.
 5. Skull. $\frac{1}{4}$.
 6. Skull, basal view. $\frac{1}{4}$.
 7. Skull, side view. $\frac{3}{16}$.
 8. Palate-ridges. $\frac{1}{4}$.

2. Contributions to the Anatomy of the Lacertilia.—(3) On some Points in the Vascular System of *Chamaleon* and other Lizards. By FRANK E. BEDDARD, M.A., F.R.S., Prosector to the Society.

[Received March 14, 1904.]

(Text-figures 1-7.)

The present communication is a continuation of a paper laid before the Society in March last* dealing with the venous system in a few genera of Lacertilia. In the present paper I deal with the venous and also, to some extent, with the arterial systems of a

* "Contributions to the Anatomy of the Lacertilia, No. 1," P. Z. S. 1904, vol. i. p. 436.

number of Lizards, more particularly with *Chamæleon*, of which I have had the opportunity of dissecting four specimens belonging to the common species, *Ch. vulgaris*. The other genera, with which I deal in a less comprehensive way, are *Pygopus* and the Geckos *Phelsuma* and *Tarentola*. Of the genus *Pygopus* we possess, so far as I am aware, no knowledge of the vascular system. *Chamæleon* has lately formed the subject of some investigations on the part of Prof. Hochstetter, to whose memoir due reference will be made in the course of the following pages. Inasmuch as that anatomist was unable, through a deficiency in injection, to give much account of the hepatic portal system, I am able to add something to the existing knowledge of that aberrant lizard, as well as to confirm a good many of the facts elucidated by Prof. Hochstetter with regard to other tracts of the venous system.

CHAMÆLEON VULGARIS.

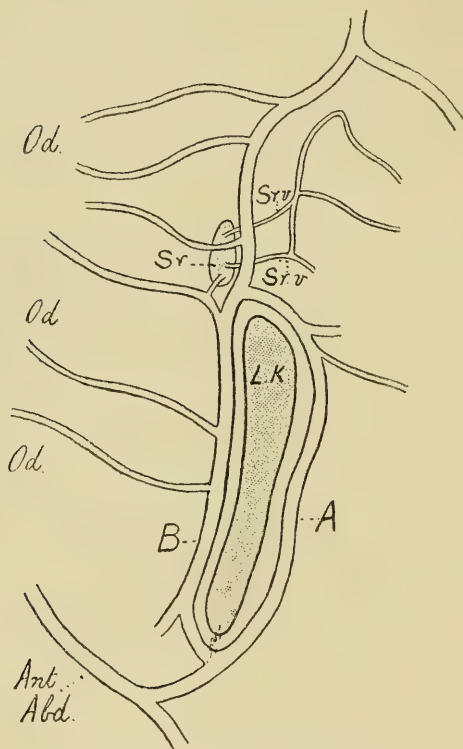
Of this species I have dissected four individuals, of which one was a male and the rest females. The male specimen was fully injected in both venous and arterial systems: one of the female examples was injected from the anterior abdominal vein, and the renal vessels were successfully filled as well as the intestinal portal system. I am therefore able to offer some facts concerning both the arterial and venous systems. The latter has been partly described by Hochstetter*, who has specially studied the renal afferent and efferent veins, with a description of which I shall begin. As that anatomist has pointed out, they differ considerably from those of other Lizards; but I shall have occasion to point out in a subsequent page that *Pygopus* resembles the *Chamæleon* in one important particular. I am further able to note those points in which the veins in question show individual variation. With Hochstetter's account I find myself quite in agreement; there are, however, a few details to which he does not refer. The afferent renal vein, which is formed by division of the caudal into the two afferent renals below the kidney, receives a number of oviducal veins of which I give a full account later. It also receives at least one vein from the dorsal parietes before the ischiadic joins it. The anterior abdominal vein arises from the afferent renal just at the line of division between the anterior wider and the posterior narrower region of the kidney. From it immediately a branch is given off which divides into two, of which the posterior supplies the dorsal parietes. The anterior branch is the one referred to by Hochstetter as joining the posterior vertebral in front of the kidney (*A* in text-fig. 1, p. 8). It appears to me that this vein may be looked upon as the equivalent of the lateral abdominal vein in other Lacertilia, for instance in *Iguana*†. If this homology be not accepted, then the vein in question is wanting in *Chamæleon*.

* "Beiträge zur Entwicklungsgeschichte des Venensystems, &c.," Morph. Jahrb. xix. p. 462.

† "On the Venous System in certain Lacertilia," P. Z. S. 1904, vol. i. p. 439.

There are, however, several points of resemblance between the two veins. In *Chamæleon*, as in *Iguana*, for instance, the lateral abdominal vein is connected with the suprarenal bodies on each side. They both arise from the anterior abdominal vein shortly after the connection of the latter with the ischiadic vein.

Text-fig. 1.

Afferent renal system of *Chamæleon vulgaris*.

A, vein communicating anteriorly and posteriorly with *B*, afferent renal. *Ant. Abd.*, anterior abdominal; *Od.*, oviducal veins; *L.K.*, left kidney; *Sr.*, suprarenal body; *Sr.v.*, suprarenal veins.

(N.B.—The branches from the afferent renal vein to the kidney are not indicated.)

The continuation of the afferent renal into the posterior vertebral is shown in the accompanying drawing (text-fig. 1). In one specimen, the injected male, I found the vein only on one side of the body, the left *. In the others it was present on both sides, and usually unequally developed on the two sides; in one the

* A similar asymmetry occurs, as will be pointed out shortly, in *Pygopus*.

left was rather longer than the right, and the reverse was the case in another specimen. I presume that these veins are the posterior cardinals; they lie exactly in the same straight line as the two azygos veins anteriorly, which are admitted to be the anterior section of the posterior cardinals. It receives branches from between the ribs running superficially over the musculature. These differ on the two sides of the body in the individual where they were best shown, a large specimen in which I describe later the oviducal veins. On the right side, close to the point where the posterior vertebral loses itself in the parietes, it receives two thinish veins from the parietes superficially. Further back, and close to the anterior end of the suprarenal body, a thicker vein, fed by two branches which run backwards and forwards respectively along the parietes, enters it. On the left side there is only one anterior vein debouching into the posterior vertebral. The corresponding vein to the thicker posterior vein on the right side opens directly into the suprarenal body, as explained later and as illustrated in the figure to which reference has already been made.

I mention later that in *Pygopus* there is a vein obviously corresponding to the posterior vertebral. There is also, as I have described, a similar vein in *Iguana** which arises from the parietes close to the median side on the left, and forms one of the afferent suprarenal vessels. In *Iguana*, as in most Lizards, the suprarenal body lies a long way in front of the kidney, hence the absence in that form of a connection between the posterior vertebral and the kidney.

In a more fully mature individual of large size, which I owe to the kindness of Mr. J. F. Ochs, F.Z.S., the veins of the kidney region were very successfully injected, and enable me to describe, which was impossible in the other specimen, the oviducal veins. There was a slight difference on the two sides of the body; on the left side three oviducal veins reach the posterior vertebral vein in front of the kidney, one crossing the suprarenal body to do so. In the region of the kidney itself three oviducal veins reach the afferent renal in front of the anterior abdominal, and at least two behind it. On the right side, the most anterior oviducal vein takes up, before reaching the posterior vertebral vein, a vein from the dorsal parietes anterior to, but in the same straight line with, the posterior vertebral at the point where it plunges into the thickness of the parietes.

Some of the oviducal veins take up a branch from the suprarenal body before joining the posterior vertebral; in other cases the afferent suprarenal veins open directly into the posterior vertebral.

A remarkable fact about the oviducal veins is the anterior termination of the longitudinal vein running along the entire oviduct into which they open. This vein could be readily traced

* *Loc. cit.* p. 443.

forwards beyond the funnel of the oviduct along the membrane which supports the oviduct, and which ends anteriorly in a transverse ligament tying the anterior border of each liver-lobe to the parietes*. The vein on each side passes along this ligament and enters the liver-lobe, forming thus a part of the hepatic portal system. I have not seen a description of a similar state of affairs in any other lizard, and I have not myself observed anything of the kind. These vessels may take the place of the dorsal parieto-hepatic trunk or trunks, which, as Hochstetter correctly notes, are apparently absent in *Chamaeleon*. Physiologically they would appear to be equivalent, since they convey blood from the dorsal parietes.

Epigastric Veins.—These veins were properly injected only in one out of the four specimens which I have been able to examine. The principal vein of the series, as in *Tiliqua*, is the median epigastric. But the two lateral epigastrics are not absent, though of diminished importance as compared with their condition in *Iguana* and in *Varanus*. They arise from the anterior abdominal of each side behind the fat-body, and run along the body-wall dorsally of the fat-body on each side. They are small vessels, and seem to end in branches of the much more important median epigastric. The latter vessel arises from the anterior abdominal just at the anterior end of the fat-body, to which it gives off a branch; whether there is a branch to the other (the left) fat-body, I do not know. The epigastric passes forwards near to the middle line and to the right of the anterior abdominal as far as the point where the anterior abdominal receives the portal vein. At this point it opens into the anterior abdominal; the main trunk, however, diminished in calibre, still continues its forward course, and seems to be connected with the ventral parietal affluents of the liver, though I am unable to make an accurate statement as to the mode of its connection. It gives off in its course a good many branches, which seem to anastomose with similar branches of the anterior abdominal.

The *anterior abdominal vein* of each side is, like that of *Varanus* (as made known by Hochstetter †), a direct continuation of the vein from the hind leg of its own side. Each receives a branch from the kidney and dorsal parietes, which has been already referred to. A peculiarity of the *Chamaeleon*, as compared with at least some *Lacertilia* ‡, is that the two anterior abdominal roots unite to form the single median unpaired trunk before they reach, and receive all the six branches from, the paired fat-bodies. The anterior abdominal vein pursues a median course between the two closely approximated fat-bodies; and here several more or less regularly arranged branches from each fat-body reach the unpaired region of the anterior abdominal.

* "On some Points in the Anatomy of *Tupinambis teguixin*," P. Z. S. 1904, vol. i. p. 465.

† *Loc. cit.* p. 467.

‡ Beddard, "On the Venous System in certain Lizards," P. Z. S. 1904, vol. i. p. 436.

It receives minute branches from the parietes throughout its whole course to the liver. Contrary to what is found in most Lizards, the portal vein joins the anterior abdominal at a long distance from the liver, in fact about halfway between the origin and termination of the vein. The system of veins of the bladder is connected with the anterior abdominal. A median vessel leaves the bladder anteriorly and joins the undivided region of the anterior abdominal. Another branch (? on each side) runs from the hinder part of the bladder to the right anterior abdominal behind the entrance of the fat-body veins.

Suprarenal Portal Veins.—As a general rule, there appears to be no distinct suprarenal portal system: the suprarenal body receives branches from the posterior vertebral vein given off along the course of the latter, which have been already referred to. But on one side of one individual there were separate suprarenal portals. This is illustrated in the accompanying drawing (text-fig. 1, p. 8). On the right side of the body two veins collecting blood from the parietes, instead of joining the posterior vertebral vein, pour their contents directly into the suprarenal body of that side. The more usual absence of an independent suprarenal system is to be explained, as I imagine, by the fact that the suprarenal bodies are closer to the kidneys than they are in some other Lizards, such as *Iguana*, where the suprarenal system is quite independent.

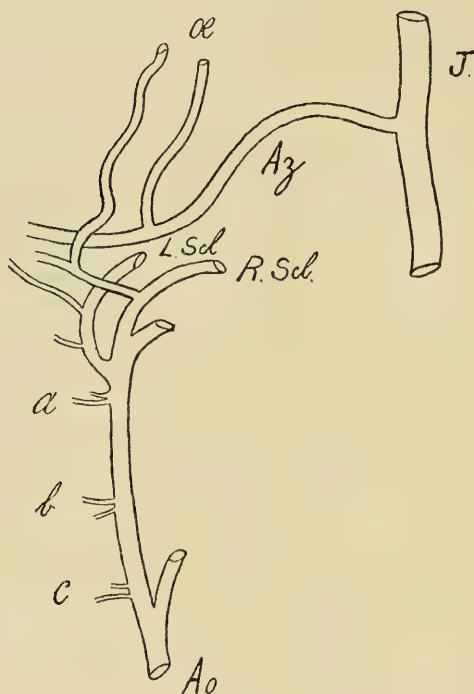
Dorsal Aorta and its Branches.—The subclavian arteries (text-fig. 2, p. 12) spring from the right aortic arch, and I observed a difference in two specimens dissected as to their mode of origin. In the one the two arteries arose independently—that of the right side being anterior to the left. In the other specimen the two subclavians sprang from a common trunk. Both subclavians give off vessels to the parietes (shown in the drawing referred to). The right-hand artery gives off a single trunk which immediately divides into two, one going to the parietes, the other supplying the cesophagus and running there in company with a branch of the azygos vein of that side. The left subclavian gives two branches to the parietes following each other, which are not paired tubes as is the case with the intercostals given off from the aorta itself. The right aorta gives off two pairs of intercostals before it joins the left. The left aorta, on the other hand, gives origin to gastric trunks, of which I counted three before the junction of the two aortæ. The gastric trunks of the common aorta arise alternately from either side of that artery, and are disposed in pairs supplying naturally each side of the stomach. There are eight of these arranged in four pairs anterior to the origin of the mesenterics.

The intercostal arteries are for the most part strictly paired, the two arteries for a given vertebra arising exactly side by side. Occasionally, however, there is an irregularity, one of the two arteries arising a little in front of the other.

As is the case with most Lizards, the gastrosplenic artery

arises behind the superior and inferior mesenterics, and crosses over them shortly after its origin. In two out of three specimens the two mesenterics arose from the aorta by a common trunk; in the third they arose separately. The succeeding arteries I have dissected only in one individual, where they were asymmetrical.

Text-fig. 2.



Certain anterior arteries and veins of *Chamæleon vulgaris*.

Ao., aorta cut short just after union of right and left aortic arches; *a, b, c*, paired intercostals; *Az.*, azygos vein; *J.*, jugular; *æ.*, oesophageal artery and vein; *R.Scl.*, *L.Scl.*, right and left subclavian arteries.

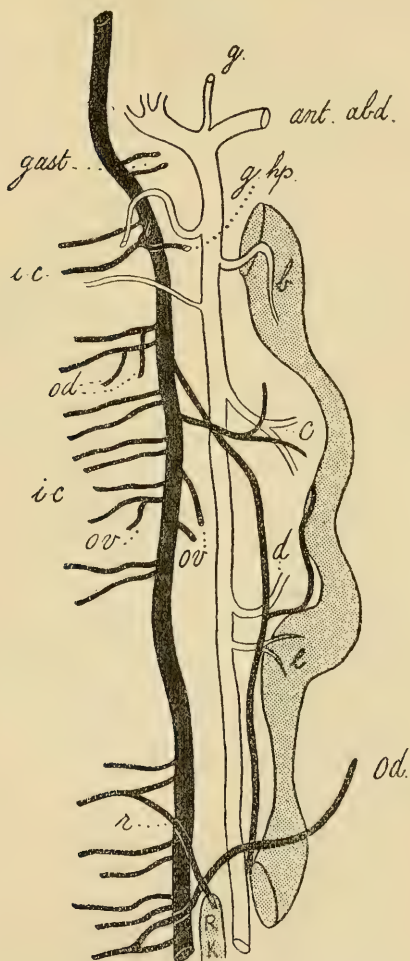
On the right side there first arise two arteries for the ovary and oviduct; then comes the renal. On the left side the ovarian artery is followed by another trunk which divides into renal and ovarian, and which lies behind the renal of the right side.

PYGOPUS LEPIDOPUS.

I have examined only one example of this species, which was not injected. The reptile, however, had died in very good condition for my purposes; for the veins were turgid with blood.

Arteries.—The aorta gives off eight branches to the stomach along its whole course. The next branch which arises therefrom

Text-fig. 3.

Visceral arteries and veins of *Pygopus lepidopus*.

ant.abd., anterior abdominal vein; *b, c, d, e*, branches of portal vein; *g.*, gastric affluent; *gast.*, gastric arteries of last pair; *g.hp.*, gastrohepatic; *i.c.*, intercostal; *od.*, oviducal; *ov.*, ovarian and suprarenal arteries; *r.*, renal; *R.K.*, right kidney.

goes not only to the stomach but to the liver and spleen. It arises in a rather curious fashion (see text-fig. 3). The vessel

springs from the ventral surface of the aorta, just in front of a pair of intercostals; it crosses one of these intercostals, but blends with that artery at the point of crossing. The next visceral artery to arise from the aorta is the oviducal of each side; these are strictly symmetrical, and each arises, not independently from the aorta, but from the intercostal of its own side. Next arises the cæcocolic artery, which is crossed shortly after its origin in the usual way* by the subsequently arising celiac trunk, which is, it will be observed, a single trunk. Upon this trunk follows the ovarian and suprarenals, of which one arises independently from the aorta and the other from the intercostal of its own side. Then occurs a long gap, the next trunk to arise being the right renal, which springs from an intercostal. So, too, and a little further back, does another oviducal artery.

On the whole, therefore, the most remarkable feature of the arterial system of *Pygopus* appears to be the origin of many of the arterial branches from the intercostals instead of directly from the aorta. Noteworthy, too, is the large number of gastric arteries, which is perhaps to be looked upon as associated with the snake-like form of this lizard.

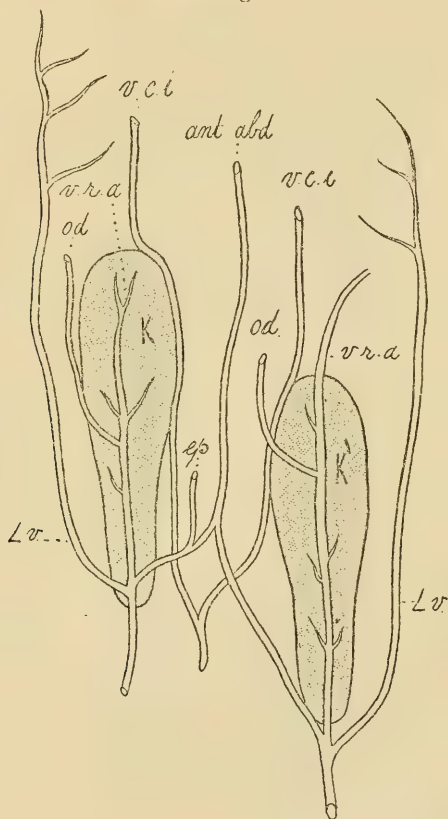
There being only rudimentary hind limbs, the system of the *venæ renales advehentes* is much simplified (Text-fig. 4, p. 15). The *caudal* vein divides into two branches, one for each kidney. Each vein soon divides into three branches, *i. e.* the anterior abdominal, the lateral abdominal, and the afferent renal. This last vein, in the case of the right kidney, runs over the gland, giving off branches, nearly to its anterior extremity. On the left side the termination of this vein was particularly interesting, as showing a distinct resemblance to the *Chamæleon*. As in the latter reptile, the vein does not end upon the kidney, but is prolonged beyond it for some little distance, and is lost in the parietes to the left of the middle line. It clearly represents the posterior vertebral vein, and its presence on one side of the body only is, it will be remembered, occasionally paralleled in *Chamæleon*. At about the middle of the kidney a vein from the oviduct (on each side) reaches the afferent renal.

The *efferent renals* arise at first as a single trunk very near to the posterior end of the kidneys, and of course between them. This trunk divides into two before reaching the middle of the kidneys. The left efferent renal receives first of all a vein from the posterior region of the left ovary, and then passes in close contact to, receiving branches from, the left suprarenal. It forms the right efferent renal just in front of the left and just behind the right suprarenal. Before their junction the right efferent renal receives a branch from the posterior region of the right ovary. Into the vena cava thus formed by the union of the two efferent renals opens first of all, and at about the middle of the right suprarenal, the anterior left ovarian vein, into which opens

* See Hochstetter's account of visceral arteries in *Lacertilia* in *Morph. Jahrb.* vol. xxvi. p. 213.

a branch collecting blood from the parietes and the left oviduct. Just beyond the right suprarenal a vein from that gland opens into the vena cava, and immediately beyond that again the anterior right ovarian vein, which—nearer to the ovary than in the case of the left ovarian veins—receives a branch from the oviduct and the membrane connecting this with the lung. The vena cava then pursues its course, without receiving further branches, to the liver.

Text-fig. 4.

Renal venous system of *Pygopus lepidopus*.

ant.abd., anterior abdominal; *K*, right; *K'*, left kidney; *Lv.*, lateral abdominal vein; *od.*, oviductal; *v.r.a.*, vena renalis advehens; *v.c.i.*, vena cava; *ep.*, epigastric.

Suprarenal Portals.—These veins are asymmetrical. The right suprarenal body has two afferent veins and the left only one. The right-hand vessels pass dorsally of the vena cava; that of the left suprarenal ventrally of the left vena renalis advehens.

The *azygos veins* are to be found on both sides of the body; but that of the right side is much the larger, and extends back, for the space of about eight ribs, some little way beyond the anterior end of the lungs. On the left side there is a very slender *azygos*, which might readily be missed on account of its delicacy. This latter receives, before entering the left jugular, a branch from the *œsophagus*. In *Chamæleon*, as I have already pointed out, the *œsophageal vein* enters the right side of the heart *via* the *azygos vein*.

Lateral Abdominal Veins.—These veins arise at the junction of each root of the anterior abdominal with the *vena renalis advehens*. They do not arise from the anterior abdominals themselves as is the case with most Lizards. Their course along the body-wall is, however, like that of many other Lizards. On the right side the vein is connected superficially by slender branches with the dorsal parieto-hepatic veins of that side. Anteriorly the veins die away.

Hepatic Portal System.—As in most, but not all, Lizards, nearly the full complement of hepatic portal vessels is present in *Pygopus*. It receives blood, that is to say, from the anterior abdominal, from the epigastric, the stomach, and the dorsal parietes. There are only wanting independent vessels from the ventral parietes present in many Lizards and so marked a feature of *Chamæleon*.

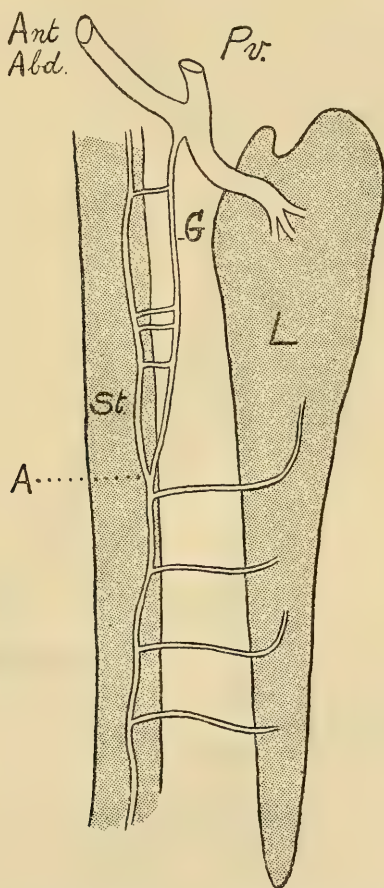
The *epigastric vein* appears to be single; if lateral epigastrics are present they are small—unless, indeed, the vessels which I homologise with the lateral abdominals of other Lacertilia are really to be looked upon as lateral epigastrics. The single epigastric lies to the left of the middle line. It is connected with the anterior abdominal by two branches just behind the liver. It gives off a large number of branches to the liver. I counted eight of these altogether: they extend along the whole of the liver, but do not arise at regular intervals, and are of unequal size. Anterior to the liver is a tract of the epigastric which gives off, at any rate, one branch to the *vena cava* before passing headwards and ending in a way that I have not been able to ascertain. It is noteworthy that here, as in *Phelsuma*, in both of which there are no marked lateral epigastrics, the median epigastric takes up a portion of the duties of the lateral epigastrics, and conveys some of the blood from the posterior abdominal region straight to the heart.

The *dorsal parieto-hepatic* vessels in this lizard are numerous and large. Altogether three of them enter the liver, and at least two of them are connected, as already mentioned, with the lateral abdominal veins by fine branches running superficially over the parietes. There are also three on the left side, more anteriorly, which communicate with the liver *via* the stomach.

There are four *gastrohepatic* vessels, which arise separately from a continuous longitudinal trunk running along the stomach, which is fed not only from the vessels of the stomach itself, but also by

four vessels emerging from the parietes on the left side of the vertebral column: these have just been referred to. This longitudinal trunk, after giving off the four gastrohepatic vessels, divides posteriorly into two branches (*A*, in text-fig. 5), which run

Text-fig. 5.

Hepatic portal system of *Pygopus lepidopus*.

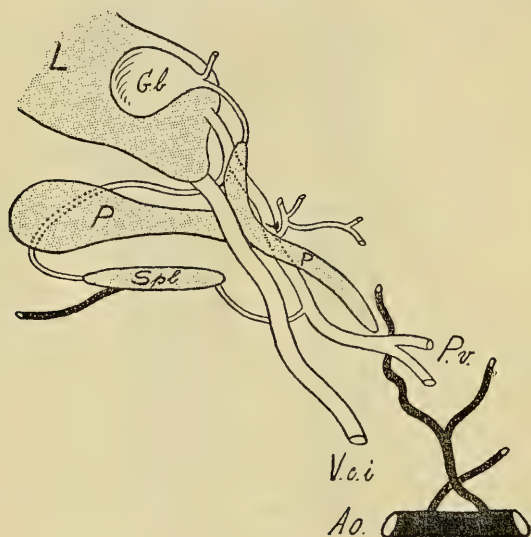
Ant. Abd., anterior abdominal; *A*, origin of *G*, gastric branch of portal;
L, liver; *Pv.*, portal vein; *St.*, stomach.

side by side, and are connected by cross-anastomoses. One of these branches joins the general portal system; the other enters the anterior abdominal vein just where it receives the portal vein.

It is a noteworthy fact about the liver of this lizard that a good many of the longitudinally running veins passing through it appear at intervals on its surface, instead of being covered throughout as is the general rule.

The *portal vein* has the following affluents (see text-fig. 3, *b*, *c*, *d*, *e*, p. 13, & text-fig. 6, *Spl.*):—a gastric branch which really belongs to the anterior abdominal system and has been already referred to; just posterior to the liver a splenic vein; behind this two veins near to each other, one of which is splenic, the other gastric; still more posteriorly a large vein which

Text-fig. 6.

Part of hepatic portal system of *Pygopus lepidopus*.

Ao., aorta with chief visceral branches; *Gb.*, gall-bladder; *L*, liver; *P*, pancreas; *P.v.*, portal vein; *Spl.*, spleen supplied by one artery and two veins; *V.c.i.*, vena cava.

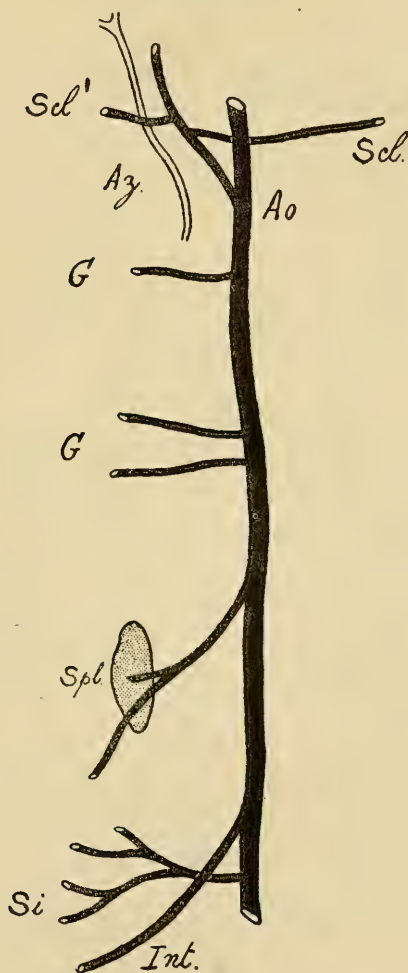
is formed of two branches, one of which is gastric, the other intestinal; behind this again another vein from the small intestine joins the common trunk; the last branch of importance is one from a dilated, almost globular, region of the small intestine. The main trunk then pursues a straight course along the rest of the gut.

PHELSUMA MADAGASCARIENSIS.

I have a few notes only to offer upon the vascular system of this Gecko, of which I have examined only a single male specimen.

The two subclavian arteries (text-fig. 7) arise independently from the right aortic arch, the right subclavian a little in front of the left. In their course within the body-cavity they are not

Text-fig. 7.

Some arteries of *Phelsuma madagascariensis*.

Ao., aorta at junction of right and left arches; *Az.*, azygos vein; *G*, gastric arteries; *Int.*, caecocolic artery; *Scl.*, subclavians; *Si.*, mesenteric; *Spl.*, spleen.

concealed by musculature as is the case with these arteries in *Tiliqua*. There are three gastric and œsophageal arteries of

secondary importance in front of the main gastrosplenic artery. Then follow, after a considerable gap, the two mesenteric arteries, which cross in the usual Lacertilian fashion*, the anterior supplying the cæcum and large intestine. The second gives rise to two main branches immediately after it has passed under the first.

Hepatic Portal System.—In addition to the anterior abdominal vein, concerning which I have nothing to say, and the median epigastric, which I describe elsewhere, the liver receives a single gastrohepatic vein and a considerable series from the dorsal parietes. There appear to be none from the ventral parietes independent of the epigastric. There are, however, no less than three dorsal parieto-hepatic vessels, of which two are larger than the third. This system is thus more conspicuously developed than in some Lizards.

Epigastric Vein.—I succeeded in discovering only the median epigastric vein in *Phelsuma*; whether the others are present or not, I am unable to say. This vein joins the anterior abdominal posteriorly, as in most Lizards, and does not seem to be prolonged further back—to the fat-bodies, for example.

Anteriorly it joins the liver after receiving an important branch from the ventral parietes. The epigastric system is, furthermore, represented by two or three veins from the ventral parietes, arising anteriorly to the entrance of the median epigastric into the liver, which do not communicate with the liver, but open into the vena cava in front of it. I observed a slight connection between the epigastric and one of these veins.

Suprarenal Portal System.—This system is by no means so clearly marked off from the general systemic circulation as it is in many Lizards. In the case of the left suprarenal body, I noticed two afferent veins arising from the parietes. One of these arises anteriorly from the parietes near to the middle line, and may be looked upon as a portion of the posterior cardinal; the second vein arises laterally and runs at right angles to the longitudinal axis of the body. These vessels seem to join a considerable plexus lying between the gonad and the vas deferens, which plexus is also continuous with the system of the vena cava through the spermatic veins.

The *azygos vein* is present only on the right side, and is not very extensive.

The anterior abdominal vein gives off anteriorly on each side a lateral abdominal before it unites with its fellow in the middle line.

TARENTOLA ANNULARIS.

The vascular system of this Gecko, so far as I have been able to examine into its details, does not show wide differences from that of *Phelsuma*. There are, nevertheless, a few facts to which

* These arteries in many Geckos are described by Hochstetter in *Morph. Jahrb.* vol. xxvi. p. 213.

I think it desirable to call attention as tending to emphasise the peculiarities of the Geckonidæ as compared with other families of Lizards. As to the apparent differences between *Tarentola* and *Phelsuma*, I am unable at present to lay much stress upon them. The arterial system shows one important agreement with that of *Phelsuma*. There are, in fact, three small gastric arteries supplying the stomach exclusively which in both genera have precisely the same arrangement; that is to say, there is one anterior artery, followed after a considerable interval by the two next which are close together.

But *Tarentola* has not a gastrosplenic artery arising after these and before the origin of the celiac, such as that which is present in *Phelsuma*.

I did not observe in *Phelsuma*—but I do not assert that it does not exist—a lateral artery on either side present in *Tarentola*. This artery is in effect a series of anastomoses between the extremities of the intercostal arteries which arise from the aorta and run along the ribs towards the ventral middle line. Whether it is to be compared to the epigastric artery of either side or not, I do not know.

The *hepatic portal system* and the single median *epigastric* vein are almost exactly like the corresponding veins of *Phelsuma*. I found, however, only a single parieto-hepatic vessel. The epigastric is connected anteriorly with the vena cava, as in *Phelsuma*.

Suprarenal Portals.—Each suprarenal body has, as in *Phelsuma*, two afferent veins. The anterior vein of the left suprarenal body passes backwards to it, arising from the side of the vertebral column. This is exactly what I observed in *Phelsuma*.

The *azygos vein* is as in the last genus.

The *lateral abdominals* appear to be rather shorter than in *Phelsuma*, plunging at once into the thickness of the parietes.

RÉSUMÉ.

It may be useful to state in a few words the chief new facts contained in this communication.

The most noteworthy new features in the vascular system of the Chamæleon as compared with those of other Lizards are:—

(1) The large number of gastric arteries situated in pairs and supplying right and left sides of the viscus.

(2) The connection of the longitudinal oviducal vein with the hepatic portal system, of which it is an affluent apparently not represented in some other Lizards.

(3) The entire restriction of the dorsoventral oviducal veins to the efferent renal and to its forward prolongation the anterior vertebral. In *Iguana*, for instance, these veins open partly into the afferent renal.

(4) The absence of conspicuous forwardly running lateral epigastrics.

(5) The short course of the lateral abdominal veins and their fusion anteriorly with the posterior vertebral.

(6) The tendency towards a disappearance of a special supra-renal portal system.

As to *Pygopus*, the following points seem to me to be deserving of special notice:—

(1) The large number of gastric arteries.

(2) The origin of a considerable number of the visceral arteries from the intercostals, and not directly from the aorta.

(3) The large number of dorsal parieto-hepatic portals, and the existence of an equal number of portals arising dorsally on the left side and reaching the liver *via* the stomach.

(4) The connection between the branches of the well-developed lateral abdominals and the dorsal parieto-hepatics.

(5) The absence, or at most small development, of lateral epigastric veins.

(6) The abundant connection (by 8 trunks) of the median epigastric with the liver and its connection anteriorly with the vena cava.

(7) The presence, as in *Chamaeleon*, of a posterior vertebral vein continuous with the afferent renal.

(8) The opening of a single oviducal vein into the afferent renal posteriorly, and of a single vein into the ovarian and thence into the caval vein anteriorly.

Concerning *Tarentola* and *Phelsuma*, there are fewer general observations to offer. But I may direct special attention to the following:—

(1) The absence of at least conspicuous lateral epigastrics.

(2) The connection of the median epigastric with the vena cava anteriorly.

(3) The restriction of the azygos to the right side.

(4) The shortness of the lateral abdominals.

3. Notes on the Gill-rakers of the Spoonbill Sturgeon, *Polyodon spathula* *. By A. D. IMMS, B.Sc. (Lond.), Assistant Demonstrator in Zoology in the University of Birmingham.

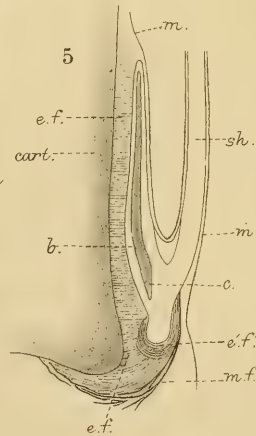
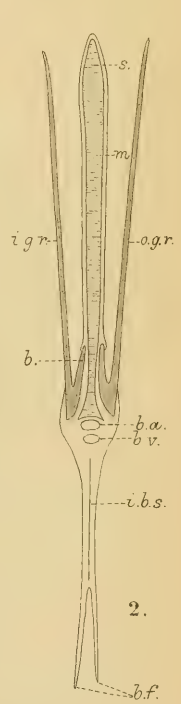
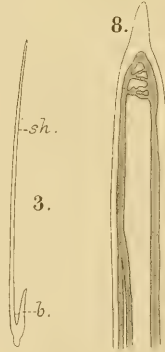
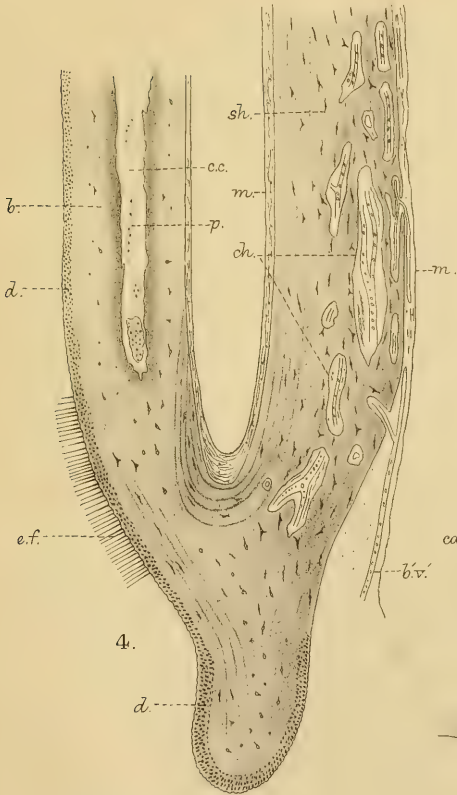
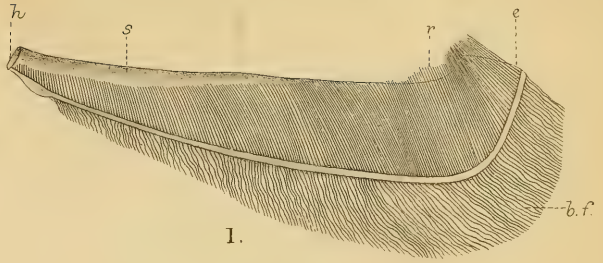
[Received April 19, 1904.]

(Plate II. †)

The gill-rakers of fishes are organs which present a considerable range of variation in form and structure, but which, as yet, have been very inadequately studied. In their most familiar form they

* Communicated by Prof. T. W. BRIDGE, F.R.S., F.Z.S.

† For explanation of the Plate, see p. 34.



occur as a single or double row of protuberances disposed along the concave inner or pharyngeal margins of the branchial arches. They may be modified, however, so as to become tooth-like, setiform, or even filamentous. In some fishes they are completely absent. Among the Elasmobranchs these structures are found in a number of species, and, as a typical example, they are well seen in *Acanthias vulgaris*. In this fish they occur as lanceolate projections which are developed principally along the anterior edges of the pharyngeal margins of the arches. In the "Basking Shark," *Cetorhinus (Selache) maximus*, they are found as a series of greatly elongated, coarse, seta-like structures which are disposed along the inner margins of the branchial arches upon both the anterior and posterior edges. A somewhat similar apparatus is described as being present in the South African "Whale Shark," *Rhinodon typicus*. Among the Holocephali the gill-rakers are small in size and are not conspicuous; they are seen in *Chimaera* as rows of small tubercles. By far the greater number of the Teleostomes possess gill-rakers, and it is in this subclass that they exhibit their widest range of variation. A contribution towards a systematic study of them in the freshwater members of the Teleostomi has been made quite recently by Zander*. He has examined a considerable number of species, and finds that in carnivorous types like *Esox* and *Lucioperca* the gill-rakers are in the form of teeth. In numerous other genera they form a sieve-like filtering-apparatus ("Siebfortsätze"), which is developed in some cases upon both edges of the branchial arches, as in *Perca*, *Acerina*, *Lota*, and the Cyprinidæ; or in others only upon the anterior edges, as in *Clupea alosa*, *Coregonus fera*, *C. albula*, and *Osmerus*. The relative fineness of the "Siebfortsätze" is correlated with the nature of the food of the species where they occur, and attains its extreme development in this respect amongst those fishes which subsist upon plankton. Popta† also has studied the gill-rakers in the Teleostomi, and has given brief descriptions of their structure and disposition in numerous species. As the result of his studies, he finds that they are specifically peculiar or diagnostic in all the forms which he examined, and interprets their arrangement and development in relation to the form of the mouth and the nature of the food. All three genera of the Dipnoi possess gill-rakers. They are largest and stoutest in *Neoceradotus*. In *Protopterus* and *Lepidosiren* they are present in the condition of minute, slender, pointed projections, and in the specimens which I examined they are slightly more delicate in the first mentioned of the last two genera.

The object of the present article is to call attention to some interesting features with regard to the structure and function of gill-rakers in the case of the "Spoonbill" or "Paddle Fish," *Polyodon spathula*. I am indebted to Prof. T. W. Bridge, F.R.S., for suggesting to me that I should examine these organs, and

* Zeitsch. für wiss. Zool. Bd. lxxv. 1903, pp. 233-258.

† Ann. Sci. Nat., Zool. t. xii. 1900, pp. 139-216.

also for his kindness in placing ample material at my disposal and for valued assistance rendered to me in various ways.

Anyone who has made even a cursory examination of the gills of this fish cannot fail to have been struck with the appearance of the regular comb-like organs which the rows of gill-rakers form on each face of the branchial arches. Although they are familiar to most zoologists and are characteristic of *Polyodon*, no one, so far as I am aware, has devoted to them more than passing notice. From among the early accounts of this fish it will serve the present purpose sufficiently if reference be made to a single source only. It is in a letter by Dr. S. P. Hildreth to the editor of the 'American Journal of Science' that the following mention is made of the gill-rakers. He remarks: "The jaws are without teeth; but the fauces are lined with several tissues of the most beautiful network, evidently for the purpose of collecting its food from the water, by straining, or passing it through the ciliary membranes, in the same manner as practised by the spermaceti whale."* Another observer, I. W. Clemens, says that *Polyodon* "had five pairs of gills which were double. Each of these duplicatures were thickly set with teeth, of about the diameter and consistence of best Russian bristles, and one and a fourth inches long."† He mentions that the particular fish he examined measured 4 ft. 8 in. in length.

Very little further information is to be gleaned from the works of any of the later writers. Reference is made to their occurrence in this fish by Owen‡; and Günther§ remarks that each branchial arch has a double series of very long setiform gill-rakers, and that the two series are separated by a broad membrane. No adequate figures of them appear to have been published by any author. A representation of a branchial arch of *Polyodon*, which also shows the very characteristic disposition of the gill-rakers, is given by Prof. Wiedersheim in the 2nd edition of his 'Vergleichenden Anatomie der Wirbelthiere,' but has been omitted in the later edition.

Before describing the gill-rakers of *Polyodon*, it will be necessary to refer to certain peculiar features in connection with the branchial arches. Each arch has undergone a remarkable antero-posterior compression, so that all its segments, and more especially the epibranchial and ceratobranchial pieces, assume the form of relatively thin cartilaginous plates. The plates are so obliquely disposed that the proper anterior and posterior surfaces look outward and inward respectively, while the concave inner and the convex outer margins are nearly anterior and posterior respectively. As usual in other fishes, the gill-rakers of the first four branchial arches form two rows in relation with each arch; and,

* "Notice of the Spoonbill Sturgeon or Paddle Fish of the Ohio (*Polyodon feuille* of Lacépède)," Silliman's Amer. Journ. of Science, vol. xii. (1827) p. 203.

† *Ibid.* p. 204.

‡ 'Comparative Anatomy,' vol. i. p. 482.

§ Brit. Mus. Cat. of Fishes, vol. viii. (1870) p. 346.

again following the general rule, they are attached to the anterior and posterior surfaces, close to the concave inner margin, in the form of an anterior and a posterior series, but from the obliquity of the surfaces of the arch the two series appear as if disposed along the outer and inner faces of an arch. They will be referred to in future, however, as the anterior or the posterior series, as the case may be.

If the gill-rakers are surveyed from the first branchial arch backwards to the fourth arch, they are seen to become progressively shorter in length, and, furthermore, those of them that are situated along the outer or anterior aspect of an arch are somewhat longer than those carried along the inner or posterior aspect of the same arch (Pl. II. fig. 2, *i.g.r.* and *o.g.r.*). Hence the series of the longest gill-rakers is carried on the outer aspect of the first branchial arch, while the row borne on the inner aspect of the fourth branchial arch is composed of the shortest gill-rakers. It is also worthy of note that the longest gill-rakers in either an anterior or a posterior series of a branchial arch are those situated nearest to the junction of a ceratobranchial with an epibranchial element (fig. 1, *r.*), the gill-rakers gradually increasing in length from the dorsal and ventral extremities of an arch until the centre of the concavity is reached, where they attain their maximum. The fifth branchial arch carries gill-rakers along its anterior surface only, and they are slightly longer than those disposed along the posterior aspect of the preceding arch. The fifth gill-arch is itself much reduced, since it retains only its ceratobranchial element, and, in correspondence with this, gill-rakers are not developed on the opposing face of the preceding arch in relation to its epibranchial cartilage, but only with the ceratobranchial*.

Owing to the extraordinary compression of the plate-like branchial arches†, combined with the attachment of the gill-rakers to their concave inner margins, the greater portion of each arch practically forms a stout cartilaginous septum, which separates the anterior from the posterior series of gill-rakers in relation with each arch, much in the same way that an inter-branchial septum would separate the double series of gill-filaments on the opposite or outer margin of a branchial arch (figs. 1 & 2). The necessity for this curious modification is by no means obvious. It would seem that, were the septum absent, such delicate and fragile organs as the gill-rakers would be very liable to get dislocated or clogged together, and perhaps damaged, through one series of gill-rakers rubbing against the other. As it is, each row is kept in a beautifully regular order, and not a single gill-raker will be noticed to be disarranged from its proper position, and all of them when not in use are closely applied to the surface of the septum. The function of this septum

* A full account of the skeleton of the visceral arches of *Polyodon* is given by Prof. T. W. Bridge in the Phil. Trans. 1878, vol. 169; *vide* pp. 702-712 & pl. 57. figs. 8 & 9.

† Lacépède (1798) speaks of the branchial arches as cartilage-plates.

appears to be to prevent the gill-rakers from becoming damaged in the way suggested, and to enable them to be stowed away in a regular order, and within a small compass, so as to admit of the closing of the operculum in the acts of respiration.

In an example of *Polyodon* the length of which measured 166 cm. (5 ft. 4 in.) from the tip of the rostrum to the extremity of the tail, the longest gill-rakers measured 45 mm. ($1\frac{3}{4}$ in.) in their greatest length; their average length is about 28·8 mm. ($1\frac{1}{8}$ in.). It will be seen upon referring to fig. 3 (Pl. II.), that each gill-raker consists of two parts, viz. a slender shaft, which tapers gradually towards its free extremity, and a basal portion, which is embedded under the mucous membrane covering the branchial arch. The basal portion in the specimen figured measures 8 mm. long and 1·5 mm. in its greatest breadth; the shaft near to where it joins the base measures ·75 mm. across. Each gill-raker is flattened from side to side at the base, while the shaft is nearly square in transverse section. In their natural position, the gill-rakers are disposed with their flat surfaces at right angles to the septum and are packed very closely together, the interval between any two scarcely measuring ·25 mm. In colour they are pale yellow-brown, and many of them are somewhat darker at their extreme points. Their surface is smooth and shining; they are extremely brittle, and when viewed with transmitted light they have a translucent appearance. When dried they are bone-coloured and perfectly opaque.

The method of attachment of the gill-rakers to the branchial arch is shown in Pl. II. fig. 5, where the lower part of one is represented. It will be seen that the basal portion is inserted just under the mucous membrane (*m.*) covering the branchial arch, and that it lies parallel with the cartilaginous septum. It is attached to a branchial arch by numerous elastic fibres (*e.f.*), which are firmly inserted into the gill-raker and form a remarkably tough, strong ligament. Some additional fibres (*e.f.f.*) closely ensheath the base at its lower extremity, and others serve to unite adjacent gill-rakers to one another. Inserted on the outside of each are some muscle-fibres (*m.f.*) which pass downwards and inwards to be attached to the cartilage of the branchial arch.

A sample consisting of ·869 grm. of the shaft portions of gill-rakers, after having been washed in distilled water and then thoroughly dried, yielded upon analysis the following chemical composition* :—

Organic matter	32·811 %.
Mineral matter	67·189 %.

The mineral matter consists of calcium phosphate 26·80 %, together with carbonates, fluorides, chlorides, and sulphates of calcium, with a little magnesium and iron.

On account of the small amount of calcium phosphate they

* I am indebted to Mr. C. J. Thompson, of the Chemical Laboratory of the Birmingham University, for undertaking this analysis.

contain, the gill-rakers differ very greatly in their chemical composition either from bone or dentine.

I found that the gill-rakers, after being decalcified and then boiled for a few minutes in a strong solution of potassium hydroxide, retained their general form, but the only sign of structure visible in them was a coarse fibrous groundwork. After a prolonged treatment with potash this disappeared, and all that remained was a small amount of a gelatinous precipitate.

If the shaft of a gill-raker be thinned by rubbing down on the surface of a fine hone, and then mounted in Canada balsam, a good deal of its minute structure can be made out. When viewed under a magnifying-power of 40 diameters, it is seen to consist of a transparent, faintly yellowish ground-substance, scattered through which are great numbers of lacunæ with canaliculi radiating from them. Running through the matrix or ground-substance in a longitudinal direction are yellowish-brown canals which contain blood-capillaries (Pl. II. fig. 6). In thin sections the ground-substance appears quite colourless, and when seen under a fairly high magnification indications of lamination are visible in it at the periphery, but they die out towards the centre. The lacunæ are for the most part slightly larger than those which are seen in a section of a human long-bone, and they bear no definite relation to the blood-channels, so that there are no indications of Haversian systems. The canaliculi are not nearly so numerous as those found in typical bone, but they are more frequently branched, and, moreover, they principally arise from the two opposite ends of a lacuna, and those belonging to one lacuna freely anastomose with those of several of the neighbouring ones (fig. 7). A very marked tendency is exhibited by the lacunæ to be disposed with their long axes parallel to the surface of the shaft with their canaliculi running in a similar direction. The channels containing the blood-capillaries, which are most numerous towards the base of the shaft (fig. 6), take the form of longitudinal canals anastomosing with one another by means of short lateral connections which are given off at frequent intervals. Traced higher up the shaft, the number of these canals becomes considerably less, and the anastomoses with neighbouring canals become fewer. As the extremity is reached they become reduced to two or three trunks, which eventually join with one another just under the extreme point (fig. 8). The exact method of the termination of the channels, however, is not easily to be seen in spirit material, owing to the small amount of blood that is present in the capillary vessels which are contained within them. In the basal portion of the gill-raker vascular channels are entirely absent, but running down the centre is a long, narrow, apparently empty cavity. The matrix is homogeneous, and exhibits in places faint traces of lamination. It is well supplied with lacunæ, and many of them differ from those found in the matrix of the shaft in having a knotted or less regular outline, and in being more profusely branched.

In a gill-raker which has been decalcified in a 10 per cent. solution of acetic acid, and afterwards stained with Kleinenberg's hæmatoxylin and cut into longitudinal sections with the microtome, some additional features may be observed (Pl. II. fig. 4). The ground-substance exhibits indications of being stratified and its layers show varied capabilities for absorbing staining-reagents. Traversing it are numerous canals, which are lined internally by a definite membrane and contain one or more blood-vessels and some loose connective tissue. In the region of the shaft the lacunæ have protoplasmic contents which are readily stained, together with one or more deeply staining bodies which are apparently nuclei. Those lacunæ which are situated nearest to the blood-channels can be distinctly seen to be in communication with them by means of their canaliculi. In the basal part of the gill-raker many of the lacunæ are shrunken in their outlines and are very poor in stainable contents. The lower part of the central cavity, which is represented at *c.c.*, appears to be nearly empty, containing only some nucleated tissue in which no definite cells are to be distinguished. The elastic fibres of the ligament, already mentioned, penetrate deeply into the substance of the base in much the same manner as the perforating fibres of Sharpey, which are composed partly of bundles of elastic fibres, pierce the circumferential lamellæ in bone. In fig. 4 (*e.f.*), where these fibres are seen in section, they appear as variously shaped dots according to the angle through which they have been cut, and they are very evenly distributed through the peripheral ground-substance. The principal blood-vessel is seen to enter the gill-raker about the point of junction of the shaft with the basal part. The vessel then breaks up into several branches, which penetrate the ground-substance and reach the canals traversing it. The mucous membrane of the branchial arch (*m.* in figs. 4 & 5), accompanied by capillaries, is prolonged upwards as a complete and continuous investment to the outer surface of the gill-raker. In a decalcified gill-raker the presence of a membrane covering it is easy to make out without cutting sections, as it can be stripped off by using a fine needle under a dissecting microscope.

The only fish which possesses gill-rakers at all comparable with those of *Polyodon* is *Cetorhinus maximus*. In this species the gill-rakers are of the same general form and, in proportion to the much greater size of the animal, they are correspondingly larger and stouter. The investigations of Hannover* and Turner† have shown, on histological grounds, that there is good reason for believing them to be very greatly elongated teeth. In common with those of *Polyodon*, they consist at their bases of a matrix permeated with anastomosing canals containing blood-vessels; in the shaft they differ in that they contain but a single canal which runs straight up to the tip. There are no lacunæ, but the matrix

* Kong. Danske Vidensk.-Selskabs Skrifter, 1868, p. 485. A résumé is given in French in the Ann. Sci. Nat., Zool. t. ix. 1868, p. 373.

† Journ. Anat. & Phys. xiv. 1879, pp. 273-286, pl. xii.

contains large numbers of coarse dentine-tubes which arise from the walls of the canals and run outwards to the periphery, where they form a layer of hard dentine. Turner regards these gill-rakers as being composed of vaso-dentine, but Tomes in referring to them adds "(?osteo-dentine)."*

It is worthy of note that in fishes of the genus *Chaetodon* and their allies the maxillary teeth appear to have been modified along the same lines as those by which the setiform type of gill-raker has been produced. As their name implies, the teeth of these fishes are bristle-like; they resemble the hairs of a fine brush in being flexible and elastic, and they are composed of a yellowish, shining, semi-transparent tissue †.

I would suggest that possibly the gill-rakers of *Polyodon* are morphologically the much modified descendants of exoskeletal structures which have migrated along with the ectoderm on to the branchial arches. The fact that the mucous membrane covering the branchial arches is regarded as being endodermal in origin, offers considerable difficulty to any idea that such structures could have developed there independently and *in situ*, unless they have arisen in the underlying mesoblast. Klaatsch, however, from a study of the placoid scales in *Mustelus* and some other Elasmobranchs, has arrived at the conclusion that their scleroblasts are ectodermal in origin and are derived from the same layer as that which gives rise to the enamel. This layer, which is at first homogeneous, becomes divided into a portion which has been usually considered to be of mesodermal origin, while the rest remains in connection with the ectoderm ‡. Hence he considers that a "dermal" exoskeleton is not mesodermal in its ultimate origin. It is worthy of note that, with regard to the pharyngeal teeth of many fishes, several writers are inclined to believe that their presence is due to a migration of the ectoderm into the cavity of the pharynx. For this reason, and on account of the difficulty of reconciling them with the presence of anything except ectoderm, I would suggest the possibility that the skeletal tissue of the gill-rakers of *Polyodon* has arisen from portions of the epiblast forming the outer portions of the gill-clefts, which have migrated on to the inner or pharyngeal margins of the branchial arches. At all events, if any migration of epiblast has taken place, the latter route seems at least as feasible as a backward migration from the stomodæum.

In *Cetorhinus* the gill-rakers retain many structural features in common with the teeth of the animal, but in *Polyodon* they appear to have undergone a more special modification along lines of their own. The structure of the teeth in the young *Polyodon* has been described by Zograf§, but, after a comparison of the

* 'Dental Anatomy,' p. 220.

† Vide Owen, 'Odontography,' pp. 8 & 105, pl. i. fig. 2.

‡ Morph. Jahrb. xxi. 1894, pp. 153-240.

§ "Ueber die Zähne der Knorpel-Ganoiden," Biol. Centralbl., Bd. vii. 1887-88, p. 181. Ann. Sci. Nat., Zool. 8 ser. t. i. p. 203, pl. 4. figs. 3, 4, & 6.

gill-rakers with his account, I have not been able to make out any salient points of resemblance between the two structures. With the exception of the rhombic plates and "fulcra" of the tail, the scales are too degenerate to admit of a similar comparison being extended to them. The plates and "fulcra" of the tail are, however, tolerably well-developed structures. The former I have examined after having thinned them, by rubbing down on the surface of a fine hone, in the same way in which the gill-rakers were treated. The matrix of a scale is colourless in thin slices and is pervaded everywhere by lacunæ which are similar to those found in a gill-raker, but it does not contain any blood-channels. The substance of the plate appears to be deposited around a longitudinal core-like centre in the matrix. Adjacent plates are united to one another by means of ligamentous connections the fibres of which penetrate deeply into their matrix. These fibres are comparable to what Hertwig calls the "Schuppenligament" of the scales of *Lepidosteus*.

In structure there is, therefore, a considerable likeness between a rhombic plate and the basal portion of a gill-raker. The matrix and its lacunæ are identical in both cases; the hollowed core or cavity in the base of the gill-raker might be compared to the core of one of the plates, and to this may be added the absence of blood-channels in both cases. The fibres which connect a gill-raker to the branchial arch, and also which bind adjacent ones together, are comparable with the ligaments which unite neighbouring scales. For these reasons I think that it is not improbable that the basal portion of each gill-raker is the homologue of a ganoid scale—*i. e.*, of one of the rhombic plates which are found along the sides of the upper lobe of the tail. The shaft or principal part of a gill-raker may correspond to a greatly elongated spine, or to one of the evanescent spines which are found in relation with each scale in the developing *Lepidosteus*, and which are regarded as representing the spinous portions of placoid scales. In *Lepidosteus*, as Nickerson has pointed out, the basal plate, which is the essential part of a ganoid scale, has come to be developed independently of the vestigial spines, instead of being a continuation of the process by which the latter are produced; and, in comparison with the basal plate of the Selachian scale, it has increased greatly in size and importance and has incorporated within itself fibres from the dermis*. In a gill-raker, it would seem that we have a basal plate which is similarly specialised, though not to so great an extent, but that there has been no corresponding reduction in the spinous portion, which, on the contrary, has become greatly elongated. It has no trace, however, of a hard dentine layer, nor of a coat of enamel or ganoin, unless the covering of mucous membrane is to be looked upon as the representative of the latter.

* Bull. Mus. Comp. Zool., Harvard, vol. xxiv. 1893, pp. 115-140.

The absence of such hard parts is to be correlated with their not being subjected to any use which would involve hard wear or much friction. In short, it is possible that the gill-rakers are to be looked upon as exoskeletal parts which were derived from an ancestral Selachian condition, where they exhibited little or no differentiation either in form or structure. Subsequently they became modified along lines of their own in order to fulfil particular functions, some migrating into the mouth to become teeth, while others passed on to the branchial arches and have given rise to the gill-rakers.

From what I have described of their structure, the gill-rakers, at least their shaft portions, appear to be composed of a substance which bears a close resemblance to osteo-dentine, if not identical with it. Osteo-dentine was defined by Owen as that type of dentine in which the matrix is arranged around the vascular channels in the form of concentric rings, and in which lacunæ similar to those of bone are found*. Tomes regards osteo-dentine as a substance which is developed by calcification proceeding through the interior of a pulp, and not by means of the calcification of a special layer of cells (odontoblasts) as is the case with other types of dentine. Consequently, in a tooth or structure composed of osteo-dentine there is no single pulp, but pulp and calcified tissue are quite inextricably mixed up, the vascular channels containing masses of pulp-structure as well as blood-vessels. In vaso-dentine there is a distinct pulp-cavity from which radiate canals which contain minute blood-vessels only. He further calls attention to the fact that in some teeth neither of the characteristics defined by Owen occurs, though, if their manner of development be taken into account, they are unquestionably made of osteo-dentine†. Apart from any knowledge of their mode of development, the substance of the gill-rakers of *Polyodon* bears a closer likeness to osteo-dentine than to any other structure, for the following reasons. It resembles that type of dentine in the absence of a common pulp-cavity, and in the nature of the anastomosing channels which contain one or more blood-vessels and some loose connective tissue (pulp-remains?). The presence of bone-lacunæ is an additional point of resemblance, though Tomes does not look upon it as being diagnostic of osteo-dentine, since they, or spaces very similar to them, are present occasionally in other kinds of dentine.

In *Cetorhinus* the teeth are relatively greatly reduced in size, and its food consists principally of minute surface organisms. The gill-rakers serve as a straining-apparatus which prevents the food-particles from passing into the branchial sacs with the outflowing current of water. As mentioned by Prof. Turner‡,

* Comp. Anat. vol. i. p 362.

† "On the Structure and Development of Vaso-dentine," Phil. Trans. 1878, p. 40. Also Dental Anat., 2nd edition, pp. 88-92.

‡ Loc. cit. p. 275.

Cornish has stated, in an account of a supposed Basking Shark, that in front of each gill a slight comb-like apparatus extended the whole length of the ray. As the mouth was opened, the comb automatically fell back to a right angle with the gill-ray, and effectually barred the egress through the gills of anything except water taken in through the mouth*. Although this apparatus has received attention from numerous zoologists, no one, so far as I am aware, has offered any suggestion as to the means by which the gill-rakers are brought to interlock with one another when they are in use.

The occurrence of minute teeth in *Polyodon* is a well-known feature. According to Johannes Müller, there are found in young specimens (a foot long) two rows of small teeth in the upper jaw and one row in the lower jaw. Similar teeth are found on the two anterior branchial arches where they join the floor of the mouth, and upon their opposite extremities where they join the palate. He mentions that examples over 3 feet long are edentulous†. In a specimen in the Zoological Museum of the University of Birmingham which measures 88.4 cm. (2 ft. 10 in.) long, I find that there are unmistakable teeth arranged on the jaws, as Müller states; those in the upper jaw are worn down a little more than those in the lower. In another fish measuring 139.1 cm. (4 ft. 5½ in.) in length, I have been unable to detect any trace of teeth.

The nature of the food of *Polyodon* is correlated with the vestigial character of the teeth. The fish is described as stirring up with its spatulate snout the mud at the bottom of the waters of the "bayous and lowland" streams which it frequents, and feeding upon the microscopical organisms contained in it; but the evidence which supports such a statement appears to be rarely quoted, and it leads one to believe that it is not so definite as one would wish. An early writer, already referred to, namely I. W. Clemens‡, remarked that the *Polyodon* which he dissected "had no food in its intestines—all that was observable was a small quantity of substance resembling chyle, but of the consistence of honey." T. H. Bean§, quoting Prof. S. A. Forbes, says that "the long snout is useful in procuring its food, which consists chiefly of entomostracans, water-worms, aquatic plants, leeches, beetles, and insect larvæ."

In the hope of being able to furnish some additional observations, I made a careful microscopical examination of the contents of the whole course of the alimentary canal in two specimens of *Polyodon*. In both cases the food appeared to have been much acted upon by the digestive secretion and very little

* 'Zoologist,' 1870, p. 2253.

† 'Anatomie der Myxinoïden,' p. 150.

‡ Loc. cit. p. 204.

§ "Cat. of the Fishes of New York," Bull. 60 of the New York State Museum, 1903, p. 62.

could be made out with regard to its nature. The specimens had been in spirit for a long time, which greatly increased the difficulty of identification. I was able, however, to recognise among it remains of parts of the exoskeleton of insect larvae together with portions of the spiral thickenings of the tracheae, a few small Oligochaete worms, fragments of plant-remains, and some earthy matter.

There is every reason to believe that the gill-rakers of *Polyodon* are similar in function to those of *Cetorhinus*. On account of their fineness, and the closeness with which they are packed together, they would form an even more effective straining-apparatus than they do in the case of the latter fish.

In the absence of direct observations on the living fish, as to the precise method by which the gill-rakers constitute an efficient filtering-mechanism, recourse must be had to anatomical evidence. If the gill-rakers act as a filter, it is clear that the anterior series of rakers of one branchial arch must be inclined forwards so as to meet the posterior series of the preceding arch, which have become inclined backwards for the purpose, so that the two series of gill-rakers interlock or interdigitate across the cleft. Under ordinary circumstances, however, the gill-rakers are closely applied to the anterior or posterior surfaces of the flattened branchial arches to which they belong, and they do not in the least incline across a cleft, or tend to meet those of an adjacent arch on the opposite side of the cleft. In all probability the necessary movements of the gill-rakers are brought about by means of the contractions of the muscle-fibres, represented in Pl. II. fig. 5, which extend downwards and inwards from the outside of a gill-raker and are attached to the cartilage of the branchial arch. By the contraction of these muscle-fibres the gill-rakers would be pulled outwards so as to form an angle of about 60° with the septum. When the fibres are relaxed, the gill-rakers, on account of the pull that is exerted upon them by the stretched elastic fibres, would spring back of their own accord to close against the septum, and so take up the position they occupy when not in use. The anterior row carried by the first gill-arch is composed, as already mentioned, of the largest individual gill-rakers. The reason for this appears to be that they have to bridge over the interval between that arch and the hyoid, since the latter is devoid of gill-rakers.

In concluding these few notes it may be worth while to mention that the gill-rakers of the other surviving Chondrostean Ganoids differ very greatly from those of *Polyodon*, although all these Fishes share the common character of having a greatly reduced dentition. In *Psephurus* they are comparatively short and are moderate in number. In *Scaphirhynchus* they are small fan-shaped structures each of which terminates in three or four points. In *Acipenser* the gill-rakers are small, flattened, and pointed organs which differ somewhat in relative size among the various species.

Doubtless these variations in form are correlated with differences in the nature of the food in the different genera.

The most important features with regard to the gill-rakers of *Polyodon* may be summarised as follows:—

1. The gill-rakers are setiform structures, and each consists of a basal portion, which is attached by means of elastic fibres to the branchial arch, and a long, free, shaft portion which forms its principal part.
2. The matrix of a gill-raker contains numerous lacunæ which are connected with one another by means of canaliculi. In the shaft portion it contains, in addition, a series of anastomosing channels in which lie blood-capillaries and some loose connective tissue.
3. Structurally, a gill-raker bears a very close resemblance to osteo-dentine.
4. The mucous membrane covering a branchial arch is prolonged over each gill-raker in the form of a complete investing coat.
5. The necessary movements of the gill-rakers appear to be brought about by means of the contraction of some muscle-fibres which are inserted on the outside of each gill-raker and which pass downwards and inwards to be attached to the branchial arch.
6. The food of *Polyodon* consists of microscopical organisms and the gill-rakers serve as a straining-mechanism which effectually bars the entry of such particles into the gill-cavities.

EXPLANATION OF PLATE II.

- Fig. 1. A portion of the 2nd branchial arch of *Polyodon spatula* showing the general arrangement of the gill-rakers. ($\frac{1}{2}$ nat. size.)
2. A semi-diagrammatic section taken across the 2nd branchial arch (through the ceratobranchial cartilage), to show the position of the gill-rakers in relation to the septum. ($\frac{1}{3}$ larger than nat. size.)
 3. A single gill-raker. (Nat. size.)
 4. A section taken through the lower part of a gill-raker which has been decalcified and afterwards stained with Kleinenberg's hamatoxylin. The mucous membrane of the branchial arch is prolonged over the surface of the gill-raker. The matrix of the latter shows indications of lamination and numerous lacunæ are seen scattered through it. ($\times 30$.)
 5. Figure showing the attachment of a gill-raker by means of elastic fibres to the cartilage of the branchial arch. ($\times 5$.)
 6. A portion of the broadest part of the shaft of a gill-raker which has been thinned by rubbing down upon a fine hone, the preparation afterwards mounted in balsam. The matrix is seen to contain large numbers of lacunæ mostly with their axes pointing in one direction. The vascular channels are seen to anastomose with one another at frequent intervals. ($\times 40$.)
 7. Five typical lacunæ from the shaft of a gill-raker; they are seen to be in communication with one another by means of their canaliculi. From a preparation made in the same way as the one represented in fig. 6. ($\times 370$.)
 8. View of the extremity of the shaft of a gill-raker mounted whole in glycerine. This figure shows the termination of the vascular channels in the tip of the same. ($\times 20$.)

REFERENCE LETTERS.

<i>b.</i> , basal portion of gill-raker.	<i>ef.</i> , elastic fibres.
<i>b.a.</i> , branchial artery.	<i>e.f.</i> , elastic fibres surrounding lower-
<i>b.f.</i> , branchial filaments.	most extremity of gill-raker.
<i>b.v.</i> , branchial vein.	<i>h.</i> , cut end of branchial arch taken
<i>b.v.</i> , blood-vessel supplying gill-raker.	through the hypobranchial
<i>c.</i> , central cavity traversing basal	cartilage.
portion of gill-raker.	<i>i.b.s.</i> , cut edge of interbranchial septum.
<i>cart.</i> , cartilage of branchial arch.	<i>i.g.r.</i> , posterior (or inner) gill-raker.
<i>c.c.</i> , central cavity of basal portion of	<i>m.</i> , mucous membrane.
gill-raker seen in section.	<i>mf.</i> , muscle-fibres.
<i>c.h.</i> , channels containing capillary	<i>o.g.r.</i> , anterior (or outer) gill-raker.
blood-vessels and loose connec-	<i>p.</i> , loose nucleated tissue lying in
tive tissue (pulp-remains?)	central cavity.
<i>d.</i> , cut ends of elastic fibres which	<i>r.</i> , gill-rakers.
are inserted deeply into matrix	<i>s.</i> , septum formed by cartilage of
of gill-raker.	branchial arch.
<i>e.</i> , cut end of branchial arch taken	<i>s.h.</i> , shaft portion of gill-raker.
through the epibranchial	
cartilage.	

4. On the Cranial Osteology of the Fishes of the Families *Elopidæ* and *Albulidæ*, with Remarks on the Morphology of the Skull in the Lower Teleostean Fishes generally. By W. G. RIDGEWOOD, D.Sc., F.L.S., Lecturer on Biology at St. Mary's Hospital Medical School, London.

[Received April 27, 1904.]

(Text-figures 8-18.)

An investigation on the structure of the skull of the lower Teleostean fishes was begun by me some years ago for the purpose of determining what might and what might not be regarded as primitive features in the Teleostean skull, and with the object also of ascertaining the degrees of relationship existing between the various genera investigated, so far at least as the cranial characters might bear upon the subject. The work, however, was repeatedly interrupted by pressure of other occupation, and the present paper deals only with a small proportion of the whole inquiry. Descriptions of the skulls of the *Elopidæ* and *Albulidæ* are here given, and I hope before long to publish similar descriptions of the skulls of *Mormyridæ*, *Notopteridæ*, *Hyodontidæ*, *Osteoglossidæ*, and *Clupeidæ*. In the second part of the paper I offer some remarks, more or less disjointed, upon the morphology of the Teleostean skull, based upon an examination of the species of fishes detailed in the list given at the commencement of that section. The discussion of the affinities of the genera under consideration is best deferred for the present.

For the material investigated I am indebted very largely to Prof. G. B. Howes, of the Royal College of Science, and Mr. G. A. Boulenger, of the British Museum, and to them I hereby tender my sincere thanks. I wish also gratefully to acknowledge the help that I have from time to time received in the way of

suggestions and advice from Dr. A. Smith Woodward, Mr. G. A. Boulenger, and Mr. C. Tate Regan at the British Museum (Natural History).

The mode of disarticulation and preparation of the skull adopted for the purpose of the present inquiry may be recommended for general use. It is obvious that the skulls of Teleostean fishes, prepared as one now finds them in museums without the disarticulation of any of the parts, are unsatisfactory, by reason of the impossibility of studying minutely any but the most superficial bones. On the other hand, the maceration of the skulls until all the bones fall apart is equally open to objection, since, if the bones are stored loosely in a box, a great deal of time is wasted in sorting out the parts for study; while if the bones are wired at a little distance from one another in the manner introduced by Owen, the mounted skull is unnecessarily bulky, and there is always the possibility of error in the process of rearticulation; and the expense is so great as to prevent the general adoption of the method. If, however, the skull be disarticulated into four parts as described below, the whole of the bones of the skull can be studied closely, the skull when stored occupies no more room than if no disarticulation had been made; the several parts can be rapidly placed in position for studying their mutual relations, and there is no possibility of erroneous rearticulation.

From the fresh head, or one preserved in spirit, the nasal*, lachrymal, circumorbital, premaxillary, and maxillary bones of the left side are removed in one piece, and are carefully cleaned in such a way as to prevent their coming apart. The left palatine and left hyomandibular are then disarticulated from the cranium, the mandibular symphysis is severed, the left interhyal bone is disarticulated from the hyomandibular, and the whole hyomandibular-palatine arch of the left side, together with the left ramus of the mandible and the opercular bones of the left side, are removed in one piece, and are prepared without further dissociation. The whole hyobranchial skeleton (with the exception of the hyomandibular and symplectic bones) is then removed and prepared in one piece. The remainder of the skull is prepared in one piece: it exhibits all the bones of the right side in their undisturbed relations, and at the same time presents a freely exposed left view of the cranium.

It has been found convenient to consider the constituent parts of the skull grouped as follows:—

(1) *Cranium*.—The term Cranium, as applied here, is a convenient appellation for that complex of not readily separable bones disposed around the brain. It includes the vomer and parasphenoid, belonging strictly to the buccal series, and in some cases (e. g. *Osteoglossum*) the nasal bones.

(2) *Temporal and Preopercular Series*.—Post-temporal, supratemporal, subtemporal, preopercular, interopercular. The post-

* In such skulls as those of the Osteoglossidæ the nasal is not removed with this series, but is left with the cranium.

temporal bone is properly regarded as a constituent of the shoulder-girdle; but since Gill and others have laid some stress on the manner in which this bone is attached to the back of the cranium, it is expedient in the present connection to treat it as a bone of the skull. The explanation of the exclusion of the preopercular and interopercular bones from the opercular series is given on p. 68.

(3) *Circumorbital Series*.—The lachrymal bone is included in this series of bones set around the eye, but it is considered advisable to avoid the use of this name. The bone differs in no important respect from the others of the series, and it is not easy to identify if there are several sensory-canal bones present at the side of the snout. The nasal, although shut out from the orbital margin, belongs to the same category, and is included under the present head, unless it be rigidly united with the cranium as above mentioned. The term "preorbital" is employed to designate that bone which forms the anterior margin of the orbit. The word is thus not used in the same sense as it is by Allis (Journ. Morph. xiv. 1898), who, in the case of *Amia*, has applied it to the lateral ethmoid (endosteal prefrontal).

(4) *Maxillary Series*.—Maxillary, premaxillary, surmaxillary bones.

(5) *Mandibular Series*.—Dentary, articular, angular.

(6) *Hyopalatine Series*.—Hyomandibular, symplectic, quadrate, metapterygoid, entopterygoid, ectopterygoid, palatine.

(7) *Opercular Series*.—Opercular, subopercular, branchiostegial rays, jugular plate.

(8) *Hyobranchial Series*.—All the bones of the hyoidean and branchial arches except the hyomandibular and symplectic bones.

ELOPIDÆ.

ELOPS SAURUS.

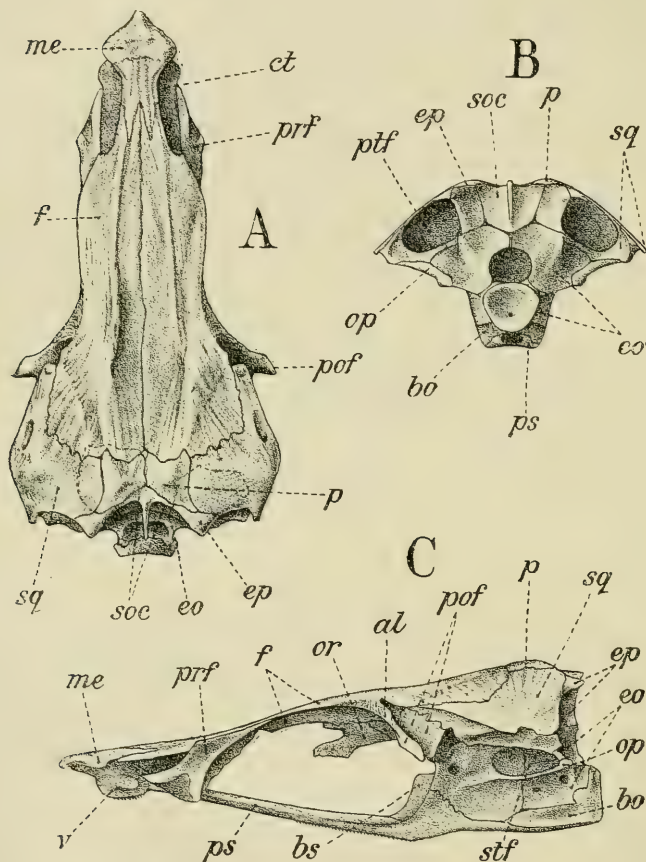
The only published figure of the skull of *Elops* appears to be that given by Agassiz in his 'Recherches sur les Poissons Fossiles,' Atlas, v. pl. G. fig. 1. The figure shows the superficial bones well, and most of them can be readily identified, in spite of the fact that no attempt has been made to label them in any way. The following remarks are based upon the examination of four skulls.

Cranium (text-fig. 8, A, B, & C, p. 38).—The cranium is moderately long and slender as seen from the side; in a dorsal view the posterior part is of considerable breadth. The parietals are small, and meet in a mesial suture. They lie over the supraoccipital, which extends well forward beneath the posterior parts of the frontals. The character of the family Elopidae given by Boulenger ('Poissons du Bassin du Congo,' 1901, p. 46), "os pariétaux séparant le susoccipital des frontaux," while applying correctly enough to *Megalops*, does not apply in the case of *Elops*. The remark is repeated without modification in the later diagnosis of the family appearing in the Ann. & Mag. Nat. Hist. 1904, xiii. p. 164. The

lateral parts of the supraoccipital are at their anterior ends in contact with the posterior edges of the alisphenoids.

The posterior temporal fossa is very extensive. It is roofed over by the frontal, squamosal, and epiotic, while its floor is formed by the postfrontal, alisphenoid, pro-otic, squamosal, supraoccipital, and exoccipital. Its aperture is bounded above by the

Text-fig. 8.

Cranium of *Elops saurus*.

A, dorsal view; B, back view; C, left side. For explanation of lettering, see p. 81.

epiotic and squamosal, externally by the squamosal, mesially by the epiotic, and ventrally by the squamosal, exoccipital, and opisthotic. The epiotic is so largely overlapped by the parietal and squamosal bones, that only its posterior part is visible in a

dorsal view of the cranium. The lateral temporal groove lies over the postfrontal bone, and is partially roofed over by a laminar extension of the squamosal.

The subtemporal fossa, beneath the facet for the reception of the posterior head of the hyomandibular, is deep and extends inwards and upwards beneath the floor of the posterior temporal fossa. Its roof is formed by the squamosal, its floor and sides by the pro-otic and exoccipital, while its internal cæcal end is formed by the supraoccipital. The opisthotic is small, and sends a process forward, below the subtemporal fossa, to meet a backwardly directed process of the pro-otic.

The basisphenoid is of fair size. Its body is embraced by the alisphenoids and pro-otics, and it has a vertical descending plate which divides the eye-muscle canal and touches the parasphenoid by its lower edge. An orbitosphenoid of moderate size is present, but the greater part of the interorbital septum is membranous.

The parasphenoid, which bears a spearhead-shaped patch of fine teeth, extends back as far as the occipital articulation, but does not project beyond. The eye-muscle canal opens posteriorly by an aperture of moderate size. The vomer has fine teeth, disposed in two patches, right and left. The ethmoid region is very largely cartilaginous. The prefrontals are purely ectosteal, while the mesethmoid is clearly of double origin, the upper part (supra-ethmoid of some authors) being a membrane-bone, while the lower part, of diminutive size, is a cartilage-bone, separating without much difficulty from the former, but firmly united with the vomer.

Temporal Series.—The supratemporal is a large thin lamina of bone with a sensory canal running along its anterior edge, which edge is in contact with the posterior edge of the parietal and squamosal bones. The hinder border of the supratemporal is deeply notched, which gives at first sight the impression that the bone is double. The mesial edge of the supratemporal lies over the supraoccipital crest, while the lateral edge overlaps the upper part of the opercular bone. The meeting of the two supratemporals in the middle line of the head is noteworthy, and is reminiscent of *Amia*.

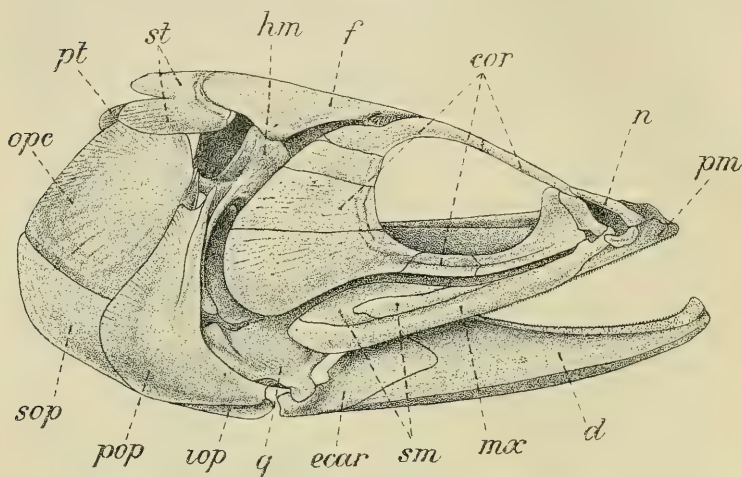
The post-temporal has one limb loosely bound by fibrous tissue to the top of the epiotic, and a shorter and more slender limb attached to the back of the opisthotic. The third limb, lying beneath the supratemporal, is very short, and just fails to reach the outer edge of the posterior temporal fossa; but projecting forward from it is an ossified tendon, which terminates in a kind of brush in the middle of the fossa, as in *Albula*.

Circumorbital Series (text-fig. 9, p. 40).—The nasal aperture is surrounded by three bones; the orbital ring is complete, and consists of seven bones.

Maxillary Series (text-fig. 9, p. 40).—The gape is large, bounded above by the premaxilla and maxilla, both of which bear densely-set minute teeth extending along the whole of their lower borders. There are two surmaxillary bones.

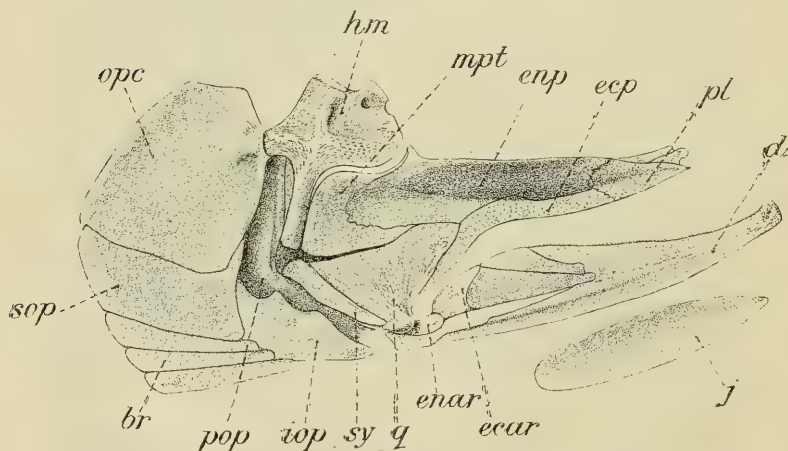
Mandibular Series (text-figs. 9 & 10).—The dentary is long, with numerous minute teeth. The distinction between the

Text-fig. 9.



Elops saurus, right side of skull. For explanation of lettering, see p. 81

Text-fig. 10.



Elops saurus, hyopalatine arch, opercular bones, &c., with mandible; left side, mesial aspect. *j*, jugular plate, dorsal view. For explanation of other lettering, see p. 81.

ectosteal and endosteal parts of the articular is clearly marked, and there is in addition a very small sesamoid articular, situated

low down, and far in advance of the endosteal articular, *i. e.* not as in *Albula*. The articular facet for the head of the quadrate is formed in its upper part by the endosteal articular, and in its lower part by the angular bone, which is fused with the ectosteal articular.

Hyopalatine Series (text-fig. 10, p. 40).—The hyomandibular articulates with the cranium by two heads, the anterior one being smaller and standing out more distinctly than the other. The palatine articulates with the ethmoid region by a single head, so far as can be seen in the dried skull. The symplectic makes with the lower limb of the hyomandibular an angle of 115 or 120 degrees. Minute teeth occur on the palatal surfaces of the palatine, entopterygoid, and ectopterygoid bones.

Opercular Series (text-figs. 9 & 10, p. 40).—The shape, size, and relations of the opercular bones are so clearly shown in the figures that no description is necessary. The branchiostegal rays are 35 in number in one specimen, which may be called "specimen A." The first one is attached just beneath the anterior end of the ceratohyal*; those that follow form a closely-set series along its ventral border, while the last fourteen are affixed to the outer face of the epihyal, and gradually become larger and flatter as one traces the series backwards. The last three extend farther forward over the outer face of the epihyal than the others, which has the effect of making the transition to the subopercular and opercular bones a very gradual one. In no modern form is it more clearly seen than in *Elops* that the opercular and subopercular are the two terminal elements of the branchiostegal series. In a larger specimen (B) the numbers are less—20 on the ceratohyal and 12 on the epihyal. In specimen C there are 29 rays on the right side and 31 on the left; in D there are 28 on each side: but in each of these specimens there are probably some rays missing. A median jugular plate is present, attached by ligament to the back of the mandibular symphysis (text-fig. 10, *j*, p. 40).

Hyobranchial Series (text-fig. 11, p. 42).—The interhyal is ossified. The epihyal is relatively large. The upper and lower hypohyals are approximately equal in size. The glossohyal is a flat cartilage, horizontally disposed, with a minute endosteal nodule in its posterior end, and bearing on its upper surface a finely dentigerous membrane-bone. The urohyal is long, and extends back as far as the anterior extremity of the fifth ceratobranchial.

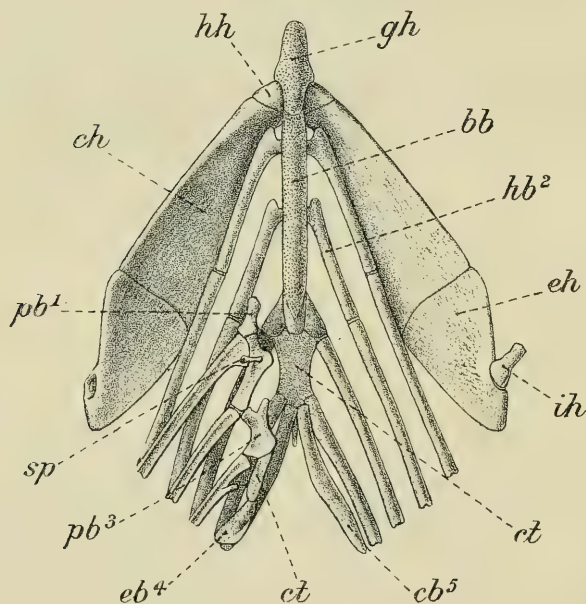
A long, finely dentigerous bone overlies the three basibranchials. The third basibranchial has degenerated in the anterior five-sixths of its length into a fatty mass, but the hinder one-sixth is a small, fairly compact bone partially covered by the long dentigerous bone just mentioned, the rest of its upper surface being covered by small, uncoalesced, readily removable dentigerous plates. The cartilage-plate representing the undifferentiated fourth and fifth

* The occurrence of branchiostegal rays along the whole length of the ceratohyal, up to its anterior extremity, is to be regarded as a primitive feature, even more primitive than the greatness of the number of the rays. *Amia* is more specialised than *Elops* in this respect.

basibranchials is roughly hexagonal in shape, elongated in an antero-posterior direction, and continued posteriorly into a small rod of cartilage which lies freely between the fifth ceratobranchials.

The dentigerous plates on the fifth ceratobranchials are readily removable, which is not usually the case. There is a true ossified first pharyngobranchial, projecting slightly upwards by the side of the parasphenoid, in addition to the small spicular bone, which in Teleosteans generally has been erroneously taken to represent the first pharyngobranchial. The spicular bone stands upright from the antero-superior extremity of the first epibranchial, and serves

Text-fig. 11.



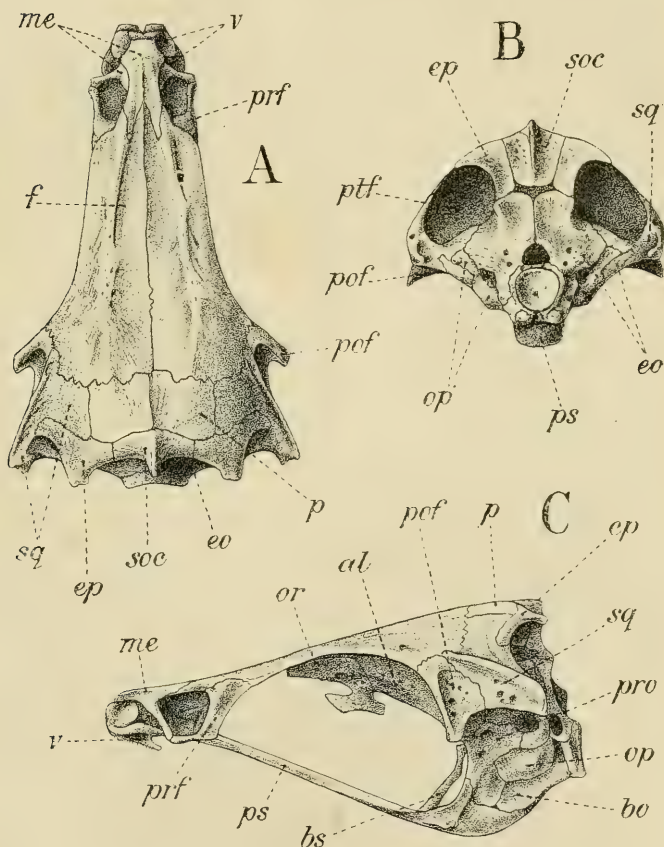
Elops saurus, hyobranchial skeleton, dorsal view. The epibranchials and pharyngobranchials of the right side are not shown. For explanation of lettering, see p. 81.

to attach the branchial skeleton to the pro-otic bone at the point where the latter meets the opisthotic bone. The fourth pharyngobranchial is cartilaginous, and is flanked on its pharyngeal surface by a dentigerous membrane-bone exactly similar to those which occur on the second and third pharyngobranchials. Even the first pharyngobranchial bears a small dentigerous plate in its posterior part. The transition from these dentigerous plates to the small toothed plates that accompany the gill-rakers on the epibranchials is quite gradual. The whole hyobranchial skeleton gives one the impression that it is in a very simple and unmodified condition.

MEGALOPS CYPRINOIDES.

The account of the skull of *Megalops* given by Shufeldt (U.S. Fish. Com. Rep. 1883 (1885), pp. 813-816 and figs. 33 and 34) is very incomplete. His remarks apply to the cranium only, and his specimen was defective in the parietal and prefrontal regions. Hay (Zool. Bull. ii. 1, 1898, p. 28) gives a side view of the hinder part of the cranium of "*Tarpon atlanticus*." The following remarks are based upon the examination of three specimens of *Megalops cyprinoides*.

Text-fig. 12.

Cranium of *Megalops cyprinoides*.

A, dorsal view; B, back view; C, left side. For explanation of lettering, see p. 81.

Cranium (text-fig. 12, A, B, & C).—The pro-otic and associated bones are drawn out in a vertical direction, so that the parasphenoid takes a sharp bend beneath the pro-otics, instead of running

nearly horizontally as it does in *Elops*. The parasphenoid does not extend as far back as the occipital articulation, but underlies the anterior two-thirds of the length of the basioccipital. The eye-muscle canal in two of the specimens examined opens posteriorly by an aperture which admits of the passage of a fairly large sewing-needle, but the canal is blind in the third specimen. The parasphenoid has a long narrow band of numerous small teeth, and the vomer bears a heart-shaped patch of similar teeth, completely or incompletely divided into a right and left half.

The endosteal mesethmoid is in rigid union with the vomer, and separates fairly readily from the ectosteal mesethmoid; this gives the appearance of the vomer being in part a cartilage-bone. A lateral process of the ectosteal mesethmoid passes downward and outward to meet a forward process of the ventro-lateral border of the prefrontal below the nasal sac. This is not present in *Elops*.

The parietal bones touch one another in the median line of the head; each is nearly square in shape. The supraoccipital does not spread far beneath the parietal bones, and does not come near the frontals. In the extinct species it appears to have extended farther forward (see Smith Woodward, Brit. Mus. Cat. Foss. Fish. iv. pl. iii. fig. 5; also page vi of the Introduction, in which the reference to *Megalops* was probably intended by the author to refer to the extinct species only).

The posterior temporal fossæ are large and extend as far forward as the orbitosphenoid bone. They communicate with one another above the roof of the brain-case, although in *Elops* they are a considerable distance apart. The roof of the brain-case is formed by the alisphenoids (which meet in the middle line above the brain*) and by a forward growth of the lower part of the supraoccipital. The supraoccipital either actually touches the alisphenoids, or a narrow tract of cartilage intervenes. The roof of the posterior temporal fossa is formed by the parietal, squamosal, epiotic, and frontal bones. The postfrontal is rather hollow, and forms part of the external wall and floor of the fossa, and the pro-otic also forms part of the floor. The lateral temporal groove, above the articular facet for the head of the hyomandibular, is broad and shallow, and is not roofed over.

The subtemporal fossa is deep, and extends inwards and upwards. It is bounded above by the squamosal, below by the exoccipital and pro-otic, behind by both squamosal and exoccipital bones, and in front by the pro-otic. The opisthotic is comparatively large. Its postero-superior part, to which the deep limb of the post-temporal is attached, is small and wedged in between the main part of the exoccipital and the part of this bone that forms the posterior border of the subtemporal fossa. The lower part of the opisthotic, however, extends forwards so as to form an important constituent of the side of the cranium. It is somewhat bullate in shape and touches the pro-otic and basioccipital. This bullate

* Hay (Zool. Bull. ii. 1, 1898, p. 32) states that in *Tarpon atlanticus* the alisphenoids meet in the mid-line below the brain. This is not the case in the specimens now under consideration.

portion of the opisthotic is wanting in *Elops*, in which genus the ventro-posterior border of the subtemporal fossa is formed by the opisthotic, and not by the exoccipital.

On opening the opisthotic bulla of *Megalops* there is presented a fairly large cavity bounded above by the pro-otic and exoccipital, posteriorly by the exoccipital and basioccipital, anteriorly by the pro-otic, internally by the pro-otic, exoccipital, and basioccipital, ventrally and externally by the opisthotic. The chamber opens postero-ventrally at the side of the basioccipital, and probably contains a diverticulum of the swim-bladder; but on this point I am unable to offer any definite statement.

In the recent *Megalops*, as in fact in the great majority, if not the whole, of the Malacopterygian fishes, the right and left pro-otic bones unite above the eye-muscle canal, and thus separate the basisphenoid from the basioccipital. I should be disposed, therefore, to regard as pro-otic that bone which in *Megalops priscus* touches the front of the basioccipital and is marked "basisphenoid" by Smith Woodward (Brit. Mus. Cat. Foss. Fish. iv. pl. iii. fig. 5; also p. 26, specimens P. 356 and P. 1698).

The basisphenoid is rather slender, and is T-shaped when seen from the front. The body of it lies between the two pro-otics and does not touch the alisphenoids. The orbitosphenoid is similar to that of *Elops*.

Temporal Series.—The supratemporal is, as in *Elops*, a large thin scale with a notched posterior border, projecting from the back of the cranial roof. That section of the sensory canal which normally runs antero-posteriorly in the post-temporal and supratemporal fails in *Megalops* to leave any impression on either of these bones, and may possibly be absent. The two supratemporals meet on the dorsum of the head. The post-temporal has an epiotic limb and an opisthotic limb, the latter being flattened, and not rod-like; the third limb is practically obsolete.

Circumorbital Series (text-fig. 13, p. 46).—This series consists of a nasal bone and nine bones around the eye; the orbital ring is incomplete above. The anterior margin of the preorbital bone enters into a more or less definite articulation with the back of that head of the maxilla which engages with the palatine. The corresponding articulation in *Elops* is of a less definite character.

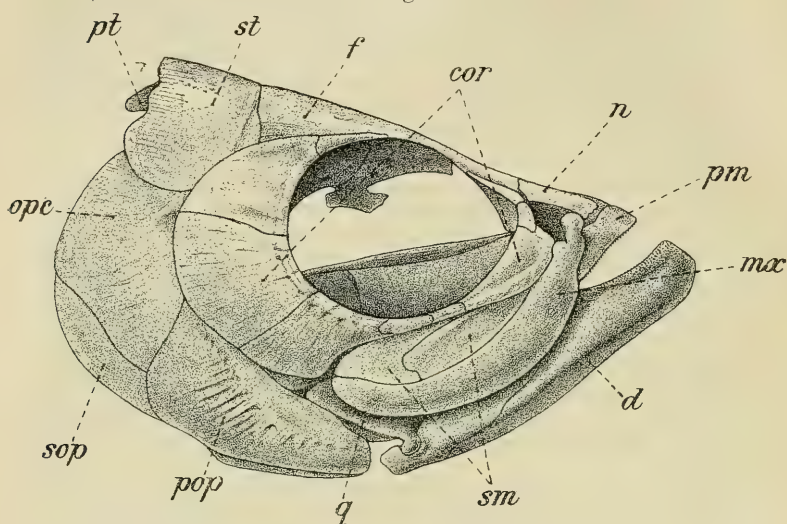
Maxillary Series (text-fig. 13, p. 46).—The gape is large, but not so large as in *Elops*; it is bounded above by the premaxilla and maxilla. The teeth are minute and densely set on the edges of both of these bones, and extend nearly to the posterior end of the maxilla. There are two surmaxillary bones of large size.

Mandibular Series (text-figs. 13 & 14, p. 46).—Except that it is much higher in proportion to its length, the mandible of *Megalops* resembles that of *Elops*.

Hyopalatine Series (text-fig. 14, p. 46).—The hyomandibular articulates with the cranium by a single moderately broad head. The palatine has a single head for articulation with the ethmoid region. The symplectic is longer and more slender than in *Elops*, but the lower part of the hyomandibular is broader, and its

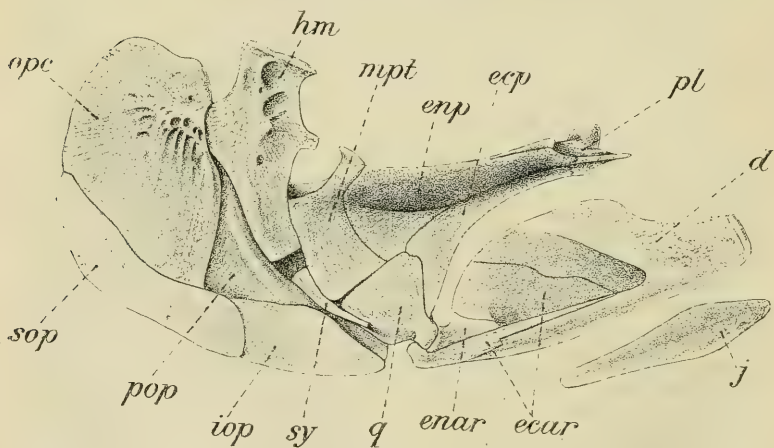
opercular head is shorter and less incised below. The symplectic does not make a definite angle with the hyomandibular, but lies

Text-fig. 13.



Megalops cyprinoides, right side of skull. For explanation of lettering, see p. 81.

Text-fig. 14.



Megalops cyprinoides, hyopalatine arch, opercular bones, and mandible of left side, mesial aspect. *j*, jugular plate, dorsal view. For explanation of other lettering, see p. 81.

in a continuation of the curved main axis of that bone. The main axis of the hyomandibular is directed downward and forward;

whereas in *Elops* it slopes downward and backward. Minute teeth occur on the palatal surfaces of the palatine, entopterygoid, and ectopterygoid bones. Hay (Zool. Bull. ii. 1, 1898, p. 39) states that in *Tarpon atlanticus* teeth may occur even on the quadrate.

Opercular Series (text-figs. 13 & 14, p. 46).—The subopercular is relatively longer and narrower than that of *Elops*. The branchiostegal rays are from 23 to 25 in number. The first thirteen are attached to the lower edge of the ceratohyal, the remainder to the outer face of the epihyal. As in *Elops*, the series extends along the whole length of the edge of the ceratohyal. The last six branchiostegal rays become gradually broader, and the last of all extends farther forward over the outer face of the epihyal than those that precede it. There is a median jugular plate (text-fig. 14, *j*, p. 46) attached by ligament to the back of the mandibular symphysis.

Hyobranchial Series.—The hyobranchial skeleton bears a close resemblance to that of *Elops*. The interhyal is ossified. The epihyal is proportionately smaller and the two hypohyals relatively larger than in *Elops*, and the endosteal glossohyal is relatively greater. The denticerous patch on the fifth ceratobranchial is readily removable, as in *Elops*. There is a first pharyngobranchial as well as the spicular bone. It stands more upright than that of *Elops*, and is attached to the antero-ventral part of the pro-otic.

ALBULIDÆ.

ALBULA CONORHYNCHUS.

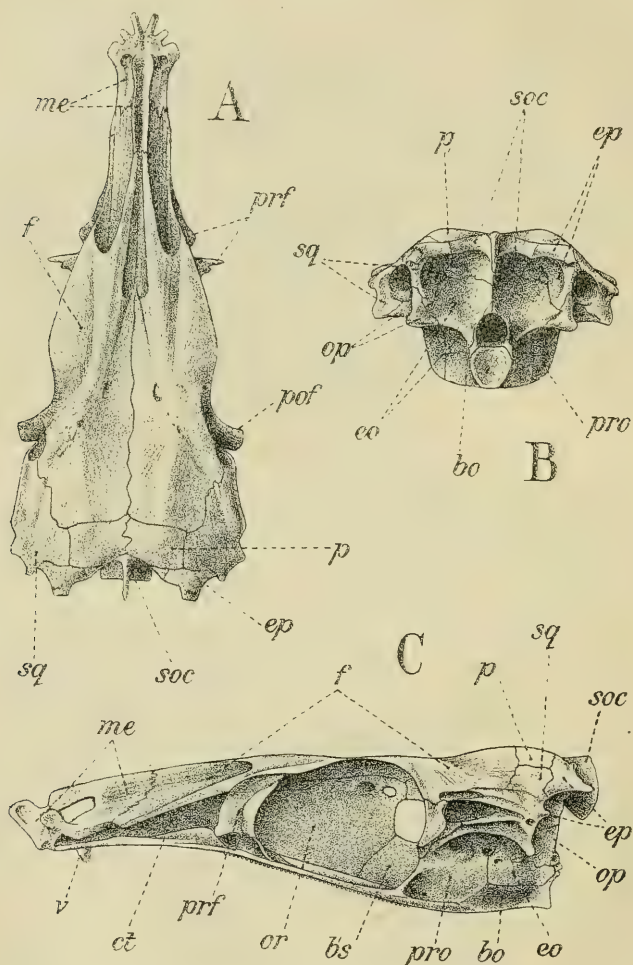
Shufeldt (U.S. Fish. Com. Rep. 1883 (1885), pp. 808–813 and figs. 28–31) has described the cranium and hyopalatine arch of *Albula*, but the other bones of the skull were apparently missing from his specimen. The following remarks are based upon the examination of two skulls.

Cranium (text-fig. 15, A, B, & C, p. 48).—The cranium is rather long, straight, and thin. The parietals are small; they are in contact in the median line, and lie over the supraoccipital in such a way that hardly more than the spine of the latter is visible in a dorsal view. The supraoccipital, however, extends well forward, even beneath the frontals, and it is therefore incorrect to state, as Boulenger does (Ann. & Mag. Nat. Hist. (7) xiii. 1904, p. 164), that the supraoccipital is separated from the frontals by the parietals. The posterior temporal fossa is roofed over by the frontal, squamosal, parietal, and epiotic; its floor is formed by the squamosal and pro-otic, its outer wall by the squamosal, and its inner wall by the pro-otic, supraoccipital, and epiotic.

The back of the cranium, immediately on the two sides of the supraoccipital crest, is so hollowed that the term vacuity might almost be applied to these depressions. At the bottom of each depression, surrounded by the supraoccipital, epiotic, and exoccipital, a small piece of the squamosal is visible (text-fig. 15, B, *sq.*). The subtemporal fossa, lying just below the posterior part of the articular surface for the head of the hyomandibular, is bounded entirely by the squamosal and exoccipital in the smaller specimen

examined, but in the larger specimen the pro-otic forms a small portion of the anterior wall. It is a deep fossa, and leads inward and upward beneath the floor of the posterior temporal fossa. The lateral temporal fossa, above the anterior part of the articular

Text-fig. 15.

Cranium of *Albula conorhynchus*.

A, dorsal view; B, back view; C, left side. For explanation of the lettering, see p. 81.

surface for the head of the hyomandibular, is bounded above by the squamosal and frontal, internally by the pro-otic and squamosal, below by the pro-otic, externally by the postfrontal, and terminally, *i. e.* antero-internally, by the alisphenoid. It is rather

remarkable that the pro-otic rises so high as to touch the frontal.

The front part of the side of the basioccipital and the lower part of the pro-otic are greatly inflated, much as in *Osmerus*. Incision into the bulla shows that it is for the accommodation of the very large sacculus, with otolith of equivalent size, and not for any diverticulum of the swim-bladder. The opisthotic is moderately small, and lies equally upon the exoccipital, epiotic, and squamosal; it sends no process forward to meet the pro-otic. The orbital surface of the alisphenoid is in a plane nearly transverse to the axis of the cranium. The basisphenoid has the form of a Y when seen from the front, but a thin plate of bone continues forward from the stem of the Y into the interorbital septum to meet the orbitosphenoid. The upper limb of the Y is attached on each side to the alisphenoid and pro-otic. The orbitosphenoid is largely developed, and, with the assistance of the basisphenoid, forms a complete osseous interorbital septum.

The parasphenoid extends very nearly to the occipital articulation, and the eye-muscle canal opens posteriorly by a small aperture. The part of the parasphenoid lying below the orbital region bears numerous hemispherical teeth, disposed in a coffin-shaped patch. Just where the front of the parasphenoid meets the back of the vomer is an oval space, which is roofed in by a forward continuation of the dorsal part of the parasphenoid. The vomer bears two or three transverse rows of pointed teeth. The ethmoid region of the cranium is long, the distance from the front of the mesethmoid to the back of the prefrontal being greater than the length of the orbit. The mesethmoid projects considerably in front of the vomer; it has a trough on its upper surface instead of the more usual ridge, and below the trough has a foramen of elliptical shape, visible in a side view only.

Temporal and Preopercular Series.—The post-temporal has three limbs. The largest lies over the epiotic, the second or deep one is more slender, and is attached by ligament to the back of the opisthotic, while the third one runs forward beneath the supratemporal and spreads out into osseous tendons, to which are attached fibres of the *trapezius* muscle, inserted into the posterior temporal vacuity. The supratemporal has a rather flat external surface, which is flush with the external surface of the squamosal. The transverse commissure of the sensory-canal system, after leaving the upper end of the supratemporal does not run in the parietal, but superficially to its posterior edge. The preopercular is bent at an angle of about 108 degrees, and the upper limb is slightly longer than the horizontal limb.

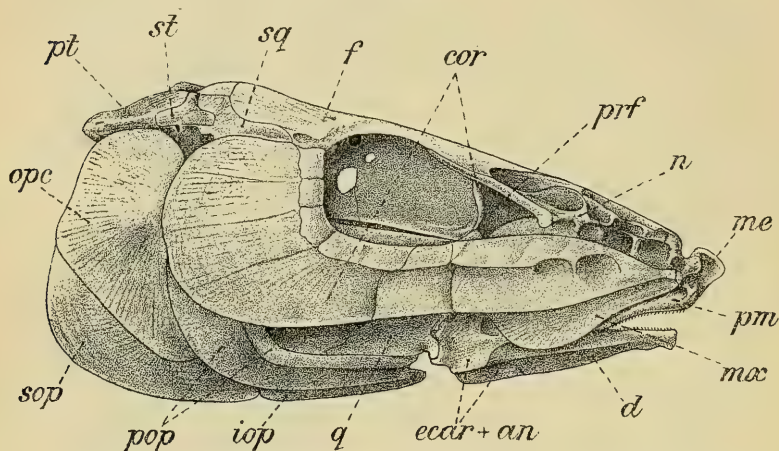
Circumorbital Series.—There are in all twelve bones of this series (text-fig. 16, p. 50). The most anterior ones are curious, basket-like bones, not much wider than the sensory canals which they carry. The canals in this region are particularly large.

Maxillary Series.—The upper part of the premaxilla is sculptured into a spongy-looking basket-work similar to that of the nasolachrymal bones. Unless the mouth is very widely opened, the

premaxilla alone bounds the gape above; the premaxillary teeth are crowded, small, and sharply pointed. The maxilla bears no teeth; the anterior extremity which articulates with the mesethmoid is sharply incurved. The surmaxilla is single.

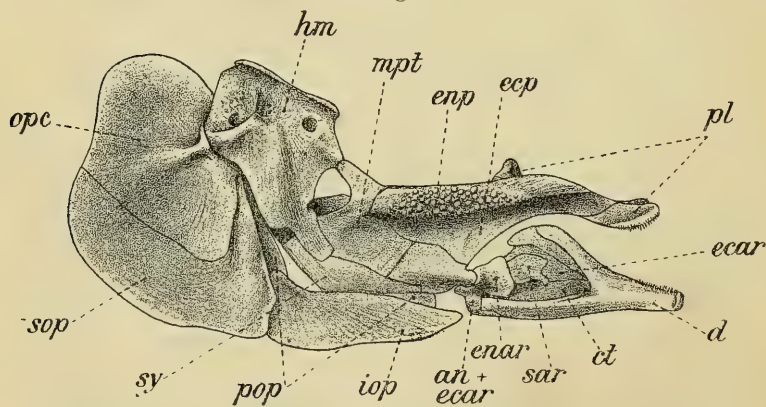
Mandibular Series (text-fig. 17).—The dentary bears teeth similar to those of the premaxilla. There is a clear distinction between the

Text-fig. 16.



Albula conorhynchus, right side of skull. For explanation of lettering, see p. 81.

Text fig. 17.



Albula conorhynchus, hyopalatine arch, opercular bones, and mandible, left side, mesial aspect. For explanation of lettering, see p. 81.

endosteal and ectosteal parts of the articular, and, lying anterior to the former and on the lingual side of the latter, is a sesamoid articular of unusually large size. The angular is not distinct

from the ectosteal articular, and the articular facet for the head of the quadrate is formed in its upper part by the endosteal articular, and in its lower part by the combined angular and ectosteal articular.

Hyopalatine Series (text-fig. 17, p. 50).—The hyomandibular articulates with the cranium by a single broad head, and its axis slopes downward and forward. Owing to the smallness of the gape the quadrate-articular joint is far in advance of the hyomandibular-cranial articulation, and the symplectic runs nearly horizontally forwards. The palatine cartilage ossifies at its anterior and posterior ends, but remains unossified for the greater portion of its length. The anterior head articulates with the mesethmoid, the posterior with the prefrontal. The ectosteal palatine is of small extent, and bears crowded, small, long, sharp teeth. It is united with the anterior of the endosteal palatines, but is remote from the posterior one. The hinder two-thirds of the palatine cartilage, and its posterior ossification, lie in a trough formed by the ectopterygoid and entopterygoid. The entopterygoid bears an elongated patch of hemispherical teeth similar to those on the parasphenoid; the ectopterygoid is toothless, or may bear two or three small teeth in continuation of the patch of teeth on the palatine. There is a prominent, externally-directed, horizontal process of the ectopterygoid, which serves to form part of the floor of the orbit. Its outer edge rests against the upper edge of two of the suborbital bones.

Opercular Series (text-figs. 16 & 17, p. 50).—The subopercular is large. The branchiostegal rays are 15 in number; they all arise from the outer face of the hyoid arch. The first two lie freely in the branchiostegal membrane, the next ten are attached to the posterior two-thirds of the ceratohyal, and the last three are attached to the epihyal. They form a well-graduated series, those in front having the form of slender curved needles, the hinder ones being larger and lamellate.

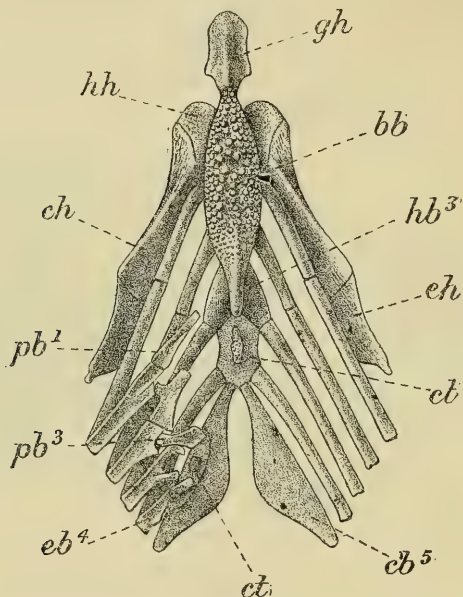
Hyobranchial Series (text-fig. 18, p. 52).—The upper and lower hypohyals are equal in size, although in an external view the lower appears to be the larger. The urohyal extends back a little beyond the posterior extremity of the third basibranchial. The gill-rakers are all short and stumpy. The interhyal is ossified.

There is a conspicuous dentigerous membrane-bone covering the first, second, and third basibranchials and the hinder part of the glossohyal. The teeth are hemispherical, and resemble those of the parasphenoid and entopterygoid, with which, in fact, they engage. The glossohyal is movable beneath this dentigerous plate, but the basibranchials are not. The body of the glossohyal consists of cartilage in front and cartilage-bone behind, and an edentulous thin membrane-bone covering both. There is a very small dentigerous bone covering that cartilage which represents the fourth and fifth basibranchials; the teeth of this are small and pointed, like those of the gill-rakers.

The first pharyngobranchial is perfectly conformable with the second, and is set in a line with the first epibranchial. A true spicular bone appears to be wanting. The third pharyngo-

branchial is peculiar, the upright limb being exaggerated, and the forward one reduced to such an extent that not only does it fail to run along the mesial edge of the second pharyngobranchial, but it does not even touch it.

Text-fig. 18.



Albula conorhynchus, hyobranchial skeleton, dorsal view. The epibranchials and pharyngobranchials of the right side are not shown. For explanation of lettering, see p. 81.

BATHYTHRISSA DORSALIS (*Pterothrissus gisu*).

I am pleased to be able to confirm a suggestion made by Boulenger ("Revision of the Mormyridæ," Proc. Zool. Soc. 1898, p. 776) that *Bathythrissa* is not intimately related with the Salmonidæ, with which family Günther had associated it (Ann. & Mag. Nat. Hist. (4) xx. p. 443; Chall. Rep. Deep-Sea Fishes, p. 221), nor with the Clupeidæ, with which family Gill grouped it (Mem. Nat. Acad. Sci. Wash. vi. 1893, p. 131), but is nearly allied to *Albula*. Smith Woodward is evidently of the same opinion as Boulenger, for in placing the genus *Istieus* in the family Albulidæ, he remarks that *Bathythrissa* is not clearly distinguished from *Istieus* (Brit. Mus. Cat. Foss. Fishes, iv. 1901, p. 67, also Introduction, p. vii).

The posterior temporal fossæ are completely roofed over, as in *Albula*, but the lateral temporal fossæ are much shallower. The relations of the opisthotic, parietal, and supraoccipital are as in *Albula*, except that the supraoccipital crest is smaller. The basi-

occipital and the lower parts of the pro-otics are inflated, just as in *Albula*, but the subtemporal fossæ are larger and shallower.

The parasphenoid and entopterygoid teeth are more pointed than those of *Albula*; the vomer and palatine are edentulous. The eye-muscle canal has no posterior opening; the basisphenoid is relatively smaller; the interorbital septum, below the orbitosphenoid, is membranous; the prefrontal is of slighter construction; the oval space in the front part of the parasphenoid is very small; the ethmoid region of the cranium is a little shorter in proportion; the top of the mesethmoid has no groove, but the oval foramen seen in a side view of the mesethmoid is present.

The shapes, proportions, and relations of the supratemporal and post-temporal are the same as in *Albula*, although I have not recognised the ossified tendons of the post-temporal projecting into the posterior temporal fossa. The sensory canals of the head, judging by the shapes of the superficial bones, are even relatively larger than in *Albula*. The circumorbital bones, the premaxilla, maxilla, and surmaxilla do not differ materially from those of *Albula*. Günther (*l. c.*) says "maxillary with a marginal row of very small teeth," but this I cannot confirm.

The mandible differs in shape in consequence of the coronoid process being situated farther forward; it is in the posterior half of the ramus in *Albula*, but in the anterior half in *Bathyrhissa*. The sesamoid articular of *Bathyrhissa* is unossified. The hyopalatine arch resembles that of *Albula*, except in the matter of teeth, noted above; the process of the ectopterygoid which passes outward and backward in the floor of the orbit to join one of the suborbital bones is longer and more slender; the nodule of cartilage which in *Albula* is ossified to form the posterior endosteal palatine is unossified in *Bathyrhissa*, and is connected by a strong ligament with a process of the orbitosphenoid which is directed forward and downward, and lies on the mesial side of the prefrontal.

The subopercular is smaller than in *Albula*, but is of the same general shape; the ventral edge of the interopercular is notched at a little behind the middle of its length. The sensory tube, which runs in the lower edge of the preopercular and beneath the ramus of the mandible, is evidently larger in *Bathyrhissa* than in *Albula*. There are only six branchiostegal rays, instead of fifteen as in *Albula*. The first four arise from the outer surface of the ceratohyal, the next from the junction of the ceratohyal and the epihyal, and the last from the outer surface of the epihyal.

The only differences to be noted in the hyobranchial skeleton are that the glossohyal has its own teeth, confined to the posterior fourth of its surface, and is not overlapped by the dentigerous membrane-bone that belongs to the three basibranchial bones. The basibranchial teeth stand higher, and are less hemispherical than in *Albula*.

Comments on the Skull of the Elopidae and Albulidae.

In reviewing the characters which are common to the skull of the Elopidae and the Albulidae, it is perhaps natural that we should

be restricted in the main to primitive features. There is no doubt that the Elopidae are the most archaic of existing Teleosteans, and that the Albulidae are in few respects more highly specialised; but the study of the skull does not show any direct affinity between the two families. There is no specialised character common to both. Such resemblances as exist between them are explicable by the fact that neither has departed to any great extent from the ancestral group from which all the Teleostean fishes sprang; and there is no evidence (from the study of the skull) that the divergence of the two families from a single one occurred at any considerable height above the root of the phylogenetic tree.

In the presence of conal valves of the heart other than those at the junction of the conus with the ventricle (see Boas, *Morph. Jahrb.* vi. 1880, p. 528), *Albula* exhibits a character common in Ganoid and still lower fishes, but not possessed by any other living Teleostean; while in the possession of a median jugular or gular plate *Elops* and *Megalops* exhibit a resemblance to the Ganoid *Amia* which is not shared by any other Teleostean fish. The Elopidae were abundant in Cretaceous times, and some of the extinct forms would seem to be more specialised than the living *Elops* and *Megalops*, since they exhibit a reduction in the size of the jugular plate (*Thrissopater* and *Spaniodon*) and a separation of the two parietal bones (*Rhacolepis*, *Thrissopater*, *Spaniodon*, and others). (See Smith Woodward, *Brit. Mus. Cat. Foss. Fish.* iv. Introduction, p. vi.)

There is no instance among Teleosteans of a paired vomer such as occurs in *Amia* and its allies, but it is worthy of note, perhaps, that in *Elops*, and to a lesser extent in *Megalops*, the vomerine teeth are disposed in two patches, right and left.

Of the characters common to the skulls of the Elopidae and the Albulidae may be mentioned the small size of the parietal bones and their meeting in the median line; the roofing of the posterior temporal fossæ; the presence of subtemporal fossæ; the presence of opisthotic, basisphenoid, and orbitosphenoid bones, an upper and lower hypohyal on each side, and an ossified first pharyngo-branchial; the distinctness of the endosteal articular from the ectosteal articular, and the fusion of the angular bone with the latter; and the presence of teeth on the dentary, premaxillary, ectopterygoid, and parasphenoid bones.

Teeth occur on the vomer and palatine in *Elops*, *Megalops*, and *Albula*, but not in *Bathyrhissa*. Minute denticles occur on the surface of the ectopterygoid in *Elops* and *Megalops*, but there are none in *Bathyrhissa* and only two or three small teeth at the front of the ectopterygoid in *Albula*. The mouth in the Albulidae is reduced in size, and its upper border is formed by the premaxillæ alone, the maxillæ being toothless, whereas in the Elopidae the upper border is supported by both premaxillæ and maxillæ, and both bear teeth. There are two surmaxillæ on each side in the Elopidae, and one in the Albulidae.

The mandibular suspensorium (hyomandibular and quadrate) is slightly tilted forwards in *Elops*; in *Albula* it is strongly rotated

in a forward direction; and in *Megalops* it has an inclination intermediate between that of *Elops* on the one hand and that of *Albula* on the other. The laterally-directed process of the ectopterygoid, which in *Albula* runs below the eyeball to meet the upper edge of the suborbital bones, is feebly suggested, in both *Elops* and *Megalops*, by a narrow, laterally projecting ledge of the ectopterygoid.

The lateral temporal fossa is roofed over in *Elops*, *Albula*, and *Bathyrhissa*, but in *Megalops* the lateral temporal groove is broad and shallow, and has no roof. The interorbital septum is completely bony in *Albula*, but it is largely membranous in the other genera under consideration. The eye-muscle canal has a posterior opening in *Elops* and *Albula*, but ends blindly in *Bathyrhissa*, and is blind in one specimen of *Megalops*, although opening in the other two. The ethmoidal region is elongated in the Albulidæ, but not in the Elopidae; and the palatine has two articulations, one in advance of the other, whereas the articular head is single in the Elopidae. While in the Albulidæ the ethmoidal rostrum projects in front of the mouth, in *Elops*, and more particularly in *Megalops*, the lower jaw projects in advance of the upper.

The supratemporals in the Elopidae are large, thin scales of bone, which meet in the dorsal median line of the head, without forming a suture; in the Albulidæ the supratemporal is more laterally placed, is smaller, and has more the triradiate character so common among Malacopterygian fishes generally. The branchiostegal rays are 32-35 in *Elops*, 23-25 in *Megalops*, 15 in *Albula*, and 6 in *Bathyrhissa*. The spicular bone present in addition to the true first pharyngobranchial in the Elopidae, is wanting in the Albulidæ.

*Remarks on the Morphology of the Skull in the Lower
Teleostean Fishes generally.*

In this section of the paper are offered some remarks, generalisations, and criticisms of published accounts of the skulls of fishes, based mainly upon an examination of the following species. Most of the skulls were specially prepared for the purpose of this research, it being found that the skulls of fishes as ordinarily prepared do not lend themselves satisfactorily to such a detailed examination as that to which it was deemed desirable to submit them in the present inquiry.

Elops saurus.
Megalops cyprinoides.
Albula conorhynchus.
Bathyrhissa dorsalis.
Mormyrops deliciosus.
Petrocephalus bane.
Gymnarchus niloticus.
Notopterus kapirot.
Hyodon alosoides.
Osteoglossum leichardti.

Arapaima gigas.
Heterotis niloticus.
Phractolemus ansorgii.
Chanos salmoneus.
Chirocentrus dorab.
Chatoëssus erebi.
Clupea finta.
Dussumieria acuta.
Engraulis encrasicolus.
Coilia nasus.

Ectosteal and Endosteal Bones.—With regard to the relation between ectosteal and endosteal ossifications in the skull of bony fishes, there is reason for believing that the ectosteal is the more primitive, and that even in the few cases in which related ectosteal and endosteal bones remain distinct, as in the postfrontal and sphenotic of *Amia**, the endosteal and ectosteal parts of the articular bone in *Amia*, *Lepidosteus*†, *Arapaima*, *Albula*, *Elops*, *Megalops*, *Hyodon*, and *Gymnarchus*, the endosteal and ectosteal parts of the mesethmoid of *Megalops*, and those of the glossohyal in a great variety of forms, the endosteal ossification has been set up in sympathy with the ossification taking place in the dermal tissues. The process of ossification is infectious, if one may employ such a term in this connection, and the increase of blood-supply, and the redistribution and alteration in the character of the cells and matrix in the one part is shared by the subjacent parts to a greater or less degree. As other examples of such related ossifications, there may be mentioned the squamosal and pterotic, the postfrontal and sphenotic in Teleosteans, the prefrontal and parethmoid and the ectosteal and endosteal parts of the angular in such forms as *Lepidosteus* and *Arapaima*, in which the upper part of the bone articulating with the quadrate, is endosteal, while the ventral surface of the bone is sculptured, and has all the appearances of a dermal bone. Having regard, therefore, to the superior antiquity of the dermal constituents of the combined bones, whether these have arisen phylogenetically around sensory canals or by coalescence of integumentary denticles—a matter ably discussed by Allis (Journ. Morph. xiv. 1898, pp. 426–431)—it is preferable to adopt the names that belong to such superficial ossifications, *e. g.* squamosal‡, prefrontal, postfrontal§. And

* An occasional feature only, although Traquair ('Ganoid Fishes Brit. Carb. Form.,' Palæont. Soc. 1877, p. 16) and Allis (Journ. Morph. ii. 3, 1889, p. 479) seem to regard it as constant.

† Van Wijhe (Nied. Arch. f. Zool. v. 3, 1882, pp. 268 & 281) regards the coronoid also of *Lepidosteus* and *Amia* as consisting of separable endosteal and ectosteal elements, which he calls the autocoronale and the dermocoronale or suprangulare. The autocoronale of *Lepidosteus*, however, is either a bone which is to be identified with the sesamoid articular (see p. 72), or is merely a thickened part of the splenial. In neither *Lepidosteus osseus* nor *L. viridis* have I been able to separate it from the splenial, yet Van Wijhe (*l. c.* pl. 16. fig. 9, *a. c.*) figures it as a separate bone. The autocoronale of *Amia*, on the other hand, the bone which is marked *d* by Bridge (Journ. Anat. & Phys. xi. 4, 1877), is a special nodule of bone developed in Meckel's cartilage in relation with the articulation between the symplectic and the mandible. (The bone *a* of Bridge is the angular; *b* and *c*, which I have never seen as two separate bones, are the endosteal articular; while the "angular" of Bridge is the ectosteal articular.)

‡ In his description of the skull of *Grammicolepis*, Shufeldt (Journ. Morph. ii. 2, 1889, p. 280 & fig. 2) discriminates between the squamosal and the pterotic. He says: "At the distal extremity of the squamosal I detect a small, flake-like piece of bone, thoroughly attached, though individualised by sutural traces, which I take to be the representatives of the pterotic." Since, however, he also letters the squamosal and pterotic separately in his figure of such a well-known skull as that of *Caranx* (fig. 6, p. 285), it would appear that no great importance need be attached to the distinction.

§ Cole & Johnstone (Proc. & Trans. Liverp. Biol. Soc. xvi. 1902, pp. 160–161), while admitting the propriety of using the term squamosal for the dermal bone lying

this will apply even in cases where the combined bone has sunk inwards and no longer presents itself as a superficial bone of the skull; as, for instance, the prefrontals and postfrontals of *Arapaima* and *Osteoglossum*, in which genera so many of the dermal bones are still dermal in position.

Even if in these latter cases it be proved by histological investigation that the bone is a pure cartilage-bone, the argument is not the less sound. The ossification in the cartilage owed its origin phylogenetically to a predisposing dermal ossification which now no longer appears in ontogeny. The terms parethmoid, sphenotic, and pterotic are, therefore, redundant; and if the occasion arises for discriminating the two parts of the prefrontal, postfrontal, and squamosal, they should be distinguished by the terms ectosteal and endosteal. This practice has hitherto been followed, more or less, in the case of the articular and palatine bones. The two constituents of the palatine of *Amia*, for instance, are called exosteal and endosteal by Bridge (Journ. Anat. and Phys. xi. 4, 1877, p. 616), while Allis (Journ. Morph. xii. 3, 1897) alludes to them as the dermopalatine and autopalatine, employing the prefixes introduced by van Wijhe (Nied. Arch. f. Zool. v. 3, 1882). The question of ectosteal and endosteal ossification in fishes has already been discussed at some length by Vrolik (Nied. Arch. f. Zool. i. 3, 1873), Gegenbaur (Morph. Jahrb. iv. Suppl. 1878), Pouchet (Journ. Anat. et Phys. xiv. 1878), van Wijhe (*l. c.* 1882, p. 210 *et seq.*), and McMurrich (Proc. Can. Inst. ii. 3, 1884, p. 280 *et seq.*); and Schmid-Monnard (Zeitschr. f. wiss. Zool. xxxix. 1883) has recorded some valuable observations on the mode of origin of such bones as the epiotic and squamosal in Teleostean fishes.

More recently, Swinnerton (Quart. Journ. Micro. Sci. 1902, p. 531, footnote) has suggested the prefixes dermo- and chondro-, "the former being used for bones which are quite free of the cartilage, and the latter for those which involve cartilage, irrespective of the degree of ossification in this, or of the retention of dermal characters." This does not seem, however, to be a very satisfactory solution of the difficulty.

Cranial Bones.—The meeting of the two parietal bones in the median line is, upon palæontological grounds, a more primitive condition than the separation of these bones by the supraoccipital, no separation of the parietals occurring in pre-Cretaceous Isospondylous fishes (Smith Woodward, Vert. Palæontology, 1898, p. 113). We have thus, to all appearances, one sound character by which to test the relative tendency towards specialisation among Teleostean fishes. But the possibility of a secondary approximation of

superficial to the pterotic and inseparable from it, do not treat the terms postfrontal and sphenotic in the same way, on the ground that the term postfrontal "cannot be correctly applied to a membrane-bone in Fishes." Why it cannot, they do not explain.

the parietal bones during evolution must be borne in mind ; and if the Berycoid fishes are to be regarded as the parental stock of the Acanthopterygians generally, a view which is supported by both comparative anatomy and palæontology, all instances of contact between the parietal bones among the Acanthopterygian fishes (*e. g.* Cyttidæ, Scorpænidæ, Triglidæ) are to be looked upon as secondary. In support of the plausibility of the hypothesis may be mentioned the parallel instance of union of epiotic bones in the middle line in such forms as *Lophius*, *Regalecus*, and *Luvarus*, this union being without doubt of secondary origin.

In *Chanos* there exists a condition which is calculated to make one pause before concluding that even within the limits of the Malacopterygian fishes the meeting of the parietals necessarily indicates the retention of the primitive condition ; for in this genus the parietals are widely separated in the young, but by subsequently fusing with the scales of the commissural section of the sensory-canal system, they come to meet above the supraoccipital bone*. They do not meet in an extensive suture ; indeed, they leave a considerable portion of the supraoccipital exposed both in front and behind ; but the condition is just sufficient to make it advisable to trace the development of the roofing-bones of the cranium in those forms in which the meeting parietal bones are thin, and beneath which bones the supraoccipital extends a considerable distance forward. This last relation, it may be observed, is the rule rather than the exception. Boulenger has already alluded to it in the case of the Salmonidæ (Proc. Zool. Soc. 1895, p. 300), and I gather that he regards the union of the two parietal bones as secondary if the supraoccipital bone can be shown to extend beneath them so as to touch the frontal bones. But if this be so, the condition found in those primitive genera *Elops* and *Albula* must be secondary, for in them the supraoccipital touches the frontals beneath the united parietal bones ; a fact evidently overlooked by Boulenger when he drew up his synopsis of the families of Teleostean fishes (Ann. & Mag. Nat. Hist. 1904, vol. xiii. p. 164).

In *Clupea*, *Chatoëssus*, and *Chirocentrus* the cranial roof is deficient towards the front of its upper surface, and a fontanelle occurs between the frontal bones and the mesethmoid. Perhaps this tendency for the frontals to remain apart points to some affinity with the Characinidæ and Cyprinidæ. In *Citharinus* such a fenestra extends the whole length of the frontal bones and involves also the parietals, while in *Alestes* a fenestra is found between the parietals and the hinder part of the frontals. A condition similar to the last occurs in such Cyprinoids as *Catostomus*, *Cyprinus*, and *Cobitis* (see Sagemehl, Morph. Jahrb. x. and xvii.).

The interfrontal suture is obliterated in *Gonorhynchus*, but it does not appear that much weight need be attached to this

* Cope (Trans. Amer. Phil. Soc. n. s. xiv. 1871, p. 455) mentions "parietals united" as one of the primary distinctive features of the family Lutodiridæ.

particular character. The persistence of the interfrontal suture in the different genera of the Murænidæ, for instance, is very inconstant.

In *Osteoglossum* the mesethmoid is separated from the frontals by the meeting of the two nasal bones in the middle line. In *Megalops* the endosteal mesethmoid is more firmly united with the vomer than with the ectosteal mesethmoid; in *Arapaima* the endosteal mesethmoid alone is present, and this does not present itself on the roof of the cranium; while in *Chanos* and the Salmonidæ an ectosteal mesethmoid is present, and the cartilage is unossified.

It is the rule among the Malacopterygian fishes for the two exoccipital bones to meet above the foramen magnum, and for the basioccipital to be excluded from the floor of the brain-cavity by the union of the two exoccipitals below the brain. The two prootics also unite beneath the brain, and form, with or without the co-operation of the basisphenoid, the roof of the eye-muscle canal.

The supraoccipital crest is evidently to be regarded as an osseous sheet developed in relation with the great trunk-muscles, and not a backward extension of the supraoccipital bone itself. *Chanos* is very interesting in this respect, in that it shows a condition intermediate between the usual vertically disposed sheet of bone and the separable brush-like tendon-bone or intermuscular bone that projects back from the supraoccipital proper in *Chatoëssus*. In the latter genus similar and separable osseous brushes project back from the epiotic bones; and in *Sphyræna* and *Mugil*, Starks (Proc. U.S. Nat. Mus. xxii. 1900) has described and figured similar brushes, but not separable, continuous with the back of the epiotic bones. Osseous brushes on the back of the exoccipital bones are of much more common occurrence, and these are discussed on p. 65.

The extent to which the supraoccipital, epiotic, and squamosal crests project backwards, and to which the hinder surface of the cranium is excavated for the better attachment of the trunk-muscles, may be taken more or less as a measure of the specialisation of the skull, since in the pre-Cretaceous bony fishes the back of the cranium is nearly flat. The excavation of the back of the cranium has doubtless originated independently in different groups; and Allis has pointed out (Zool. Bull. ii. 2, 1898, p. 92) that this must certainly have been the case in *Amia* and *Scomber*, for in the former the trunk-muscles have extended forward beneath the parietal bones, whereas in the latter they lie externally to the parietals. The degree of irregularity of the back of the skull and the dimensions of the posterior temporal fossæ appear to be in direct proportion to the muscularity of the front portion of the trunk of the fish.

The orbitosphenoid is a bone which is very variable in its form and occurrence; it is wanting in *Osteoglossum*, *Gonorhynchus*, and *Chanos*. In the majority of the lower Malacopterygian fishes it

constitutes an ossification in the upper part of the interorbital septum; but in the Mormyridæ and in *Albula* and *Arapaima* it extends the full height from parasphenoid to frontal. In the latter genus it is a paired bone—a very unusual feature in Teleostean fishes, and reminiscent of *Amia*. As a rule the bone is single, being formed by the confluence (although possibly not during ontogeny) of right and left constituents, the union being greatest ventrally, so that the bone in transverse section has the appearance of a U, or a Y, or a T, or an I. Shufeldt, it is to be noted, speaks of orbitosphenoids in the plural in his description of the skull of *Grammicolepis* (Journ. Morph. ii. 2, 1889, p. 280), but it does not necessarily follow that in this statement he intends to convey the idea that the right and left parts are really separable; Hay, for instance, speaks of “orbitosphenoids ankylosed in the mid-line as in the salmon” (Zool. Bull. ii. 1, 1898, p. 32). It is to be borne in mind, further, in dealing with the orbitosphenoid that Boulenger still uses the term in the sense in which Owen employed it, *i. e.* as a designation for the bone which is now more commonly termed the alisphenoid (see Brit. Mus. Cat. Fishes, ed. 2, i. 1895, p. 113, fig. C, *Percichthys*; and ‘Poissons du Bassin du Congo,’ 1901, p. li, *Lates*).

The alisphenoid bones are usually separated, but in *Notopterus* they meet one another behind the orbitosphenoid. In *Megalops* the alisphenoids unite above the brain.

A basisphenoid is very generally present in the lower Teleostean fishes, and has the form of a Y or a T when viewed from the front; but it appears to be wanting in *Arapaima*, *Heterotis*, *Osteoglossum*, *Gonorrhynchus*, *Chanos*, *Mormyrus*, and *Mormyrops*. It is large in *Albula*, and assists the orbitosphenoid in forming a complete bony interorbital septum (text-fig. 15, C, p. 48).

The eye-muscle canal (*myodome* of American writers) opens posteriorly by a relatively large aperture, bounded right and left by the posterior laminae of the parasphenoid, in *Clupea*, *Dussumieria*, *Chirocentrus*, and *Engraulis*, and in a somewhat similar manner in *Chatoëssus*, although the free wings of the parasphenoid are here wanting. The canal also opens posteriorly in *Hyodon*, *Albula*, *Elops*, and *Megalops*; but in the Osteoglossidæ, the Mormyridæ, and in *Notopterus* and *Chanos* it terminates blindly. The canal is open in the Salmonidæ; but owing to the large amount of cartilage present in the cranium, and the consequent shrinkage on drying, the appearances presented by the dried skulls are apt to be misleading.

While some importance may perhaps be attached to the fact that the eye-muscle canal either opens posteriorly or terminates blindly—the facts stated in the last sentence are rather against this conclusion—no value can be ascribed, so far as I can see, to a feature upon which Cope has laid some stress (Trans. Amer. Phil. Soc. n. s. xiv. 1871, pp. 454 & 455), namely, the double or simple nature of the basis cranii. This refers, so far as I understand his writings, to the separation of the parasphenoid

from the pro-otic floor of the cranium by the eye-muscle vacuity. The character is one which is very difficult of application; and it is a matter of individual opinion whether such a form as *Clupea* is to be regarded as having a simple or double basis cranii, for here the parasphenoid is produced backward into a pair of large lateral wings, the space between which is freely open below; and again, to attempt to discriminate, as Cope does, between *Notopterus* and *Osteoglossum* by the former having a "double basis cranii" and the latter a "simple basis cranii" is futile.

Since the terms posterior and lateral temporal grooves (or fossæ, as the case may be) have not always been employed in the same sense in connection with the cranium of Teleostean fishes, it may be well to explain that in this paper the prefix "posterior temporal" is applied to that groove or fossa which lies immediately external to the epiotic bone, and the "lateral temporal" to that depression which lies posterior to, and sometimes also above, the postfrontal bone, just above the anterior part, or the whole, of the articulation between the hyomandibular and the cranium. This, I believe, is the most generally accepted usage of the expressions. The former space is occupied by the *trapezius* and trunk-muscles (Vetter, Jena. Zeitschr. xii. 1878), the latter by the *dilatator operculi* and other muscles. The posterior temporal groove is roofed over to form a posterior temporal fossa in *Arapaima*, *Osteoglossum*, *Albula*, *Elops*, *Megalops*, and *Chanos*.

In *Clupea*, *Dussumieria*, *Chatoëssus*, *Chirocentrus*, and *Eugraulis* there is an aperture—the "temporal foramen"—in the side of the cranium, bounded by the parietal and frontal bones. This in life is occupied by a fatty mass, and in the dried skull leads directly from the posterior temporal groove to the cavum cranii. A short distance behind this is a lateral depression—the "pre-epiotic fossa"—situated immediately in front of the epiotic bone, and bounded by the parietal, squamosal, and epiotic. In *Coilia* there is a small aperture immediately above the most dorsal part of the upper of the two swim-bladder vesicles, which may possibly correspond with the temporal foramen of *Clupea* and its allies, but the relations of the parts are rather aberrant. Even in *Engraulis* the pre-epiotic fossa is largely obliterated by the bulging of the squamosal vesicle. The bottom of the depression is composed of cartilage in *Dussumieria* and in *Clupea harengus*, as also in *Osmerus*, where, too, a shallow pre-epiotic fossa is recognisable. In *Hyodon* and in *Coregonus pollan*, on the other hand, there is no fossa, but a similar tract of cartilage is present, bounded by the parietal, squamosal, and epiotic bones.

The large aperture—the "lateral cranial foramen"—in the side of the cranium of *Notopterus* and the Mormyridæ is bounded by the squamosal, epiotic, and exoccipital*, and may possibly be

* It is not bounded in *Notopterus* by the postfrontal and squamosal as stated by Boulenger (Poissons du Bassin du Congo, 1901, p. 115, and Ann. Mag. Nat. Hist. 1904, vol. xiii. p. 164), nor in the Mormyridæ by the opisthotic and parietal (Poiss. Bass. Congo, p. 49).

homologous with the pre-epiotic fossa. If the pre-epiotic fossa of *Clupea* were to become larger and deeper, the exoccipital would probably form part of its margin. The relation of the supra-temporal bone to the lateral cranial foramen in the one case and to the pre-epiotic fossa in the other, suggests a morphological equivalence.

The lateral temporal groove is fairly well roofed over in *Albula*, *Chanos*, and *Heterotis*, and partially so in *Elops*, *Arapaima*, *Osteoglossum*, *Hyodon*, and *Notopterus*.

In *Osteoglossum*, *Albula*, *Elops*, and *Megalops* there is a depression of considerable size in the side of the cranium, situated beneath the posterior part of the articular surface for the head of the hyomandibular. This is the "subtemporal fossa"; it is bounded by the pro-otic, squamosal, exoccipital, and opisthotic bones. The fossa is recognisable in *Arapaima*, but it is only a shallow depression. According to Hay (Zool. Bull. ii. 1, 1898, p. 30) it is well developed in the Cretaceous genus *Xiphactinus*, in which it was erroneously described by Cope as a foramen.

As already shown by Sagemehl (Morph. Jahrb. xvii.) the subtemporal fossa attains to great dimensions in such Cyprinoid fishes as *Cyprinus*, *Leuciscus*, *Labeo*, and *Abramis*—it is practically wanting, however, in *Cobitis* and *Botia*. In the former Cyprinoids it is situated more posteriorly with respect to the articular facet for the hyomandibular than is the case in the genera mentioned at the beginning of the preceding paragraph, and it opens vertically downward instead of downward and outward. It is so large and deep as to be separated from the dorsal surface of the skull by but a single layer of bone (epiotic bone). In these fishes the subtemporal fossæ serve for the lodgment of the great muscles which, by pulling up the inferior pharyngeal bones (fifth ceratobranchials), bring the teeth upon those bones forcibly against the callous pad that is carried by the under surface of the basioccipital bone.

The subtemporal fossa is not present in the Salmonidæ. It appears in the form of a wide but shallow depression in *Prochilodus*, *Alestes*, and *Hydrocyon**, but the fossa is unrecognisable in the majority of the Characinidæ.

The "auditory fenestra," bounded by the pro-otic, exoccipital, and basioccipital, and leading into the perilymphatic cavity, is present in *Chatoëssus*, *Chirocentrus*, *Clupea*, *Dussumieria*, *Engraulis*, and *Hyodon*. In the last-named genus it is traversed by a vertical bar of the pro-otic.

There are cæcal diverticula of the swim-bladder contained in the squamosal and pro-otic bones respectively in *Chatoëssus*, *Chirocentrus*, *Clupea*†, *Dussumieria*, *Engraulis*, and *Coilia*. *Megalops* has a cavity in its opisthotic, which is probably occupied by a similar diverticulum, although I have not had an opportunity of tracing the connection with the swim-bladder; but in *Elops* there

* See, for instance, Sagemehl, Morph. Jahrb. x. 1, 1884, pl. 2. figs. 13 & 14.

† In *Clupea sprattus* the pro-otic vesicle alone is present.

is no such cavity. The swim-bladder diverticulum in *Hyodon* and *Notopterus* is of an entirely different character. It is large in size, its outer wall is of fibrous tissue, and its inner wall is constituted by the exoccipital and basioccipital in the former, and the opisthotic and basioccipital in the latter genus. The want of uniformity in the relations of the air-vesicles in the above-mentioned fishes, coupled with the occurrence of such vesicles in Mormyroids, in which the relations are yet again different, points to the conclusion that such adaptive features cannot be relied upon to any large extent in determining whether any two fishes are closely or distantly related.

The opisthotic or intercalary bone does not appear to be at all constant in bony fishes, as has already been pointed out by Vrolik (Nied. Arch. f. Zool. i. 3, 1873), Klein (Jahresh. Ver. vaterl. Naturk. Württ. xxxv. 1879), and Sagemehl (Morph. Jahrb. ix. 2, 1883). It must here be borne in mind, however, that what Gill calls the opisthotic is not the bone that is now generally known as the opisthotic, but the squamosal, which is of invariable occurrence. (See Proc. U.S. Nat. Mus. xiii. 1890 (1891), pl. 30. figs. 2-4, and pl. 31. figs. 2, 4, & 5.) In this matter he appears to be following the now obsolete terminology of Huxley (see Günther, 'Study of Fishes,' 1880, p. 60). Except in the Gadoid fishes, the opisthotic is never of very large size. It is well developed in *Hyodon* and *Megalops*, and is moderately large in *Notopterus*, *Gonorhynchus*, *Osteoglossum*, *Arapaima*, and *Heterotis*; in most of the Clupeidæ it is small; it is absent in *Engraulis* and *Coilia*, in the Mormyridæ and in *Alepocephalus*.

As a general rule, in the forms under consideration, the lateral wing of the parasphenoid that passes up along the anterior edge of the pro-otic is of very small extent. In *Osteoglossum leichardti*, however, it rises so high as to meet the alisphenoid, and in *Osteoglossum bicirrhosum*, *Osteoglossum formosum*, and in *Gonorhynchus* it enters into relation with both alisphenoid and postfrontal. This is not exactly comparable with what occurs in *Amia*, for in that genus there is one long process of the parasphenoid to the endosteal postfrontal (sphenotic), and a separate shorter one to the alisphenoid. It may here be noted that Swinnerton (Quart. Journ. Micro. Sci. xlv. 4, 1902, p. 532), in mentioning the union of processes of the parasphenoid and frontal immediately in front of the postfrontal bone in *Gastrosteus*, quotes Klein as having recorded a similar relation obtaining in the case of *Lophius*. The junction, however, in *Lophius* occurs in front of the optic foramen, and is in no way comparable with the above.

Although the view of Leydig (Zeitschr. f. wiss. Zool. v. 1854), Hertwig (Arch. f. mikr. Anat. xi., Suppl. 1874; also Morph. Jahrb. ii. 1876), Sagemehl (Morph. Jahrb. ix. 2, 1883), and Klaatsch (Morph. Jahrb. xxi. 2, 1894), that such bones as the vomer and parasphenoid have arisen by the coalescence of tooth-bases, is not shared by Walther (Jen. Zeitschr. xvi. 1882) and Carlsson (Zool. Jahrb. viii. 2, 1894), who claim that tooth-bearing

bones arise independently of the teeth, it is not unreasonable to assume that the presence of teeth on these bones indicates a more primitive condition than the absence of teeth—unless, of course, the teeth are of secondary, and not primary origin. A general review of the skull in Teleostean fishes certainly goes to show that, although no broad conclusions can be drawn from the presence or absence of teeth on the vomer, a dentigerous parasphenoid is habitually associated with other features which may be regarded as archaic. Of the genera examined, *Elops*, *Megalops*, *Albula*, *Arapaima*, *Osteoglossum*, *Notopterus*, *Hyodon*, and the *Mormyridæ** have teeth on the parasphenoid.

There is probably in a considerable number of the lower Teleosteans the half of a vertebral centrum fused with the basioccipital and exoccipitals to form the hollow-cone articular surface at the back of the cranium, so that the cranial articulation really takes place between this half-centrum and the first free centrum. Such a condition has long been known to exist in *Amia*, in which the corresponding neural arch persists; and Shufeldt (Rep. U.S. Com. Fish. 1883 (1885), p. 816) has shown that in *Megalops* the suture between the half-centrum and the exoccipitals and basioccipital is readily recognisable. When this half-centrum is removed, the transverse end of the basicranial axis presents a rough surface, with a suture of the shape of an inverted T or Y separating the basioccipital below and the right and left exoccipitals above. In all of the forms at present under consideration, the upper part of the suture between the half-centrum and the exoccipitals is recognisable in the floor of the foramen magnum, although the suture may no longer be visible down the side of the half-centrum; and in these cases the half-centrum can only be removed by the application of some force, and the inverted T suture above mentioned be brought into view.

In the Salmonidæ, in *Hyodon* and in *Heterotis*, although there is not a very definite articulation between the first centrum and the basioccipital and exoccipitals, and only a very slight range of movement is possible between these, the centrum separates quite readily, and exposes the triradiate or inverted T suture, as already figured by Gegenbaur (Festschr. A. v. Kölliker, Leipzig, 1887, pl. i. fig. 9) and Parker (Phil. Trans. vol. 163. 1873 (1874), pl. viii. fig. 8). The condition thus approximates to that which is so commonly met with in the Acanthopterygian fishes, where the cranial articulation is definitely between the basioccipital and exoccipitals in front and the first vertebra behind.

In *Arapaima* the occipital articulation is further complicated by the fact that the first complete centrum, although free from the half-centrum in front of it, is not capable of free play, since its lower portion sends forward a pair of long, stout processes which are rigidly united by oblique, jagged sutures with the back of the parasphenoid.

* The parasphenoidal teeth are rudimentary in *Mormyrops* and absent in *Gymnarchus*.

In *Gonórhynchus* the back of the basioccipital region of the skull is hemispherical. This convexity of the occipital articulation is not, however, peculiar to this genus, for Owen and Klein have recorded the occurrence of such a convex articular surface in *Fistularia* (Anat. of Vert. i. 1866, p. 107; and Jahresh. Württ. 1881, p. 325), and Klein in *Syngnathus*, *Phyllopteryx*, *Gasterotokeus*, and *Ostracion* (Jahresh. Württ. 1885, p. 108).

Temporal and Preopercular Series.—The post-temporal is a constituent of the pectoral girdle rather than of the skull, but a description of the skull can hardly be considered complete unless mention be made of the manner in which the attachment with the shoulder-girdle is effected, and this, very naturally, leads to a consideration of the post-temporal bone itself. The post-temporal bone is no doubt primarily a scale-bone of the sensory-canal series. It carries the lateral line forward to the supratemporal bone, and the forward limb of the post-temporal is fairly well developed in *Engraulis* and *Chirocentrus*. The other two limbs, to the epiotic and opisthotic respectively, are usually much larger and better defined than the forward limb that passes towards the supratemporal and squamosal. The extremity of the epiotic limb is usually loosely attached above the epiotic prominence by a broad, short ligament, but in *Chatoëssus* the connection is much more intimate and the freedom of play is greatly restricted. In *Notopterus* the epiotic limb is wanting.

The opisthotic limb of the post-temporal is absent in *Alepocephalus*, *Coilia*, and the Mormyridæ; in *Gymnarchus* both epiotic and opisthotic limbs are wanting. In *Engraulis* the opisthotic limb is attached to the back of the exoccipital in the absence of a distinct opisthotic bone. The opisthotic limb lies deeper than the epiotic limb, and appears not to be part of the dermal bone at all, but rather one of the numerous intermuscular bones, at the back of the cranium, which has acquired a secondary connection with the post-temporal. The limb is always more or less rod-like (except in *Megalops*), and unlike the two more superficial limbs. In *Clupea finta* and in *Chanos* it forms the outermost element of a series of three nearly parallel intermuscular bones, which gradually increase in size from within outwards. The innermost of the three is attached to that part of the exoccipital which forms the lateral boundary of the foramen magnum; the second is attached to the exoccipital bone midway between this point and that process of the opisthotic to which the deep limb of the post-temporal is attached. The posterior ends of the inner and middle rods spread out like stiff brushes among the trunk-muscles. In *Chirocentrus* there are three brushes of tendon-bones on each side of the back of the cranium; one arises from the exoccipital immediately dorso-laterally to the vertebral articulation, the second from the exoccipital a little more laterally, and the third from that part of the exoccipital that touches the mesial edge of the opisthotic. This last tendon-bone lies immediately mesial to

the opisthotic limb of the post-temporal. In *Osteoglossum* also there are two important intermuscular bony brushes on each side.

These osseous brushes are probably far more common in their occurrence than is generally suspected, and the reason that they have not attracted more notice in the past is probably due partly to the fact that anatomists have been disposed to discount their value as constituents of the skeleton (although they are just as important as epipleural bones, which are not disregarded when dealing with the vertebral column), and partly also because the preparateur dissects them away from the back of the cranium when removing the skull from the vertebral column, and they thus become thrown away with the muscles of the trunk. They have been noted, however, in the Black Bass and the Tunny by Shufeldt, who calls them "occipital ribs" (Rep. U.S. Fish. Com. 1883 (1885), p. 805). Hyrtl (Denkschr. Akad. Wiss. Wien, xxi. 1863, p. 3), with considerable acumen, has likened those at the back of the skull of *Chanos* to the ossified tendons of birds.

Such intermuscular brushes are not confined to the exoccipital and opisthotic bones. In *Chatoëssus* they occur on the supraoccipital and epiotic prominences, and in *Chanos* the supraoccipital spine is produced back into a bony brush exactly similar to that of *Chatoëssus*, except in that it is not a separate structure. In *Gonorhynchus* the posterior end of the outer intermuscular bone is connected with the post-temporal by means of fibrous tissue. There is no opisthotic limb of the post-temporal besides this, which is clearly the opisthotic limb which has failed to establish the usual osseous connection with the post-temporal. In *Albula*, in addition to a fully developed opisthotic limb, there is an ossified tendon which projects forward from the inner surface of the post-temporal bone into the posterior temporal fossa, where it branches among the fibres of the *trapezius* muscle.

The supratemporal may in a general way be described as that dermal bone which receives the lateral line from the post-temporal and transmits it to the squamosal, and gives off a branch to the parietal (e. g. *Clupea*), or to one or more tubular scales of the transverse commissure of the sensory-canal system separable from the parietal (e. g. *Albula*, *Salmo*). The form of the supratemporal is thus triradiate. In *Gonorhynchus*, however, in which also the commissural scales are separable from the parietals and supraoccipital, the forking of the canal-system occurs just in front of the supratemporal, so that this bone is a plain tubular scale.

The supratemporal is a bone which lies either above or posterior to the squamosal ridge, and either below or external to the epiotic ridge; and Collinge (Proc. Zool. Soc. 1895, p. 291) is undoubtedly right in questioning the correctness of Parker's application of the term supratemporal to that bone of the lateral-line system which in the Salmon lies above the preopercular and below the squamosal ridge (Phil. Trans. vol. 163. 1873, p. 99, and pl. 6. fig. 1, *st*). Parker's "supratemporal" appears to correspond exactly with that bone which in *Chanos* lies immediately above the opercular

bone and carries the sensory canal from the antero-ventral corner of the supratemporal downwards to the upper end of the preopercular. This bone I propose to term the *subtemporal*. The real supratemporal of the Salmon was overlooked by Parker altogether, although it is a larger bone than the subtemporal. It lies between the post-temporal and the back of the squamosal, and bears the usual triradiate sensory canal. In Bruch's 'Vergleichende Osteologie des Rheinflachses' (Mainz, 1861), a work to which, curiously enough, Parker refers (*l. c.* p. 142), both supratemporal and subtemporal are correctly shown, the former being marked α''' (pl. 2. fig. 1) and the latter α .

The subtemporal attains its greatest development, so far as I am aware, in the Characinid genus *Sarcodaces*, in which it appears as a kind of supraopercular bone. Smith Woodward (Proc. Zool. Soc. 1887, p. 536) has recorded the occurrence of a similar bone in *Rhacolepis*, a Cretaceous Teleostean from Brazil which he is disposed to associate with the Elopidae.

In *Arapaima* and *Osteoglossum* the supratemporal is a stout, partially sculptured bone, firmly united with the cranium (squamosal and parietal bones). In the Mormyridæ it is a large, thin scale of bone forming a loose lateral cover to the lateral cranial foramen, and in *Notopterus* the relations are the same, although the supratemporal bone itself is much smaller. In *Hyodon* the supratemporal is a large curved scale of triangular shape, which unites in the dorsal median line with its fellow of the opposite side, and covers the whole of the parietal and a small part of the frontal as well. In his "Synopsis of the Families of Teleostean Fishes" (Ann. & Mag. Nat. Hist. (7) xiii. 1904, p. 164) Boulenger groups the Mormyridæ with the Hyodontidæ on the ground that they both have the "supratemporal large, plate-like, covering the greater part of the parietal bone." As a matter of fact the supratemporal of the Mormyridæ covers very little of the parietal. In *Petrocephalus bane* it just overlaps the lateral edge of the parietal, in *Mormyrus oxyrhynchus* it just touches the postero-lateral corner, while in *Mormyrops deliciosus* and *Gymnarchus niloticus* it does not reach the parietal at all.

In *Elops* and *Megalops* the supratemporal is a scale extending inwards as far as the median plane of the head, overlapping the top of the opercular bone, and attached by its anterior edge to the transverse parieto-squamosal ridge. The transverse commissure of the sensory-canal system thus does not run in the parietal, but above it. Each supratemporal is notched behind, giving the impression of a transverse row of four bones. In *Dussumieria* the notch completely divides the bone, giving a series of four, the laterals of which, according to the foregoing definition, alone can claim to be regarded as supratemporals. In *Chanos* there is a series of eight such bones. Those nearest the median plane are narrow tubular bones, the next are fused early with the parietals (the former fuse later with the latter), then come the supratemporals, and outermost of all the subtemporals.

A very definite relation exists between the supratemporal and preopercular bones. Disregarding a few exceptional cases, the supratemporal is a bone which is distinguished by a triradiate sensory canal, as already pointed out. The posterior tube is continued back into the post-temporal, the upper tube runs over the cranium, usually in or over the parietal bones, as the transverse commissure, while the antero-ventral tube, after traversing the superficial part of the squamosal, passes down into the preopercular*, either directly or through a subtemporal bone. The opercular and subopercular bones and the branchiostegal rays, on the other hand, carry no sensory canal, but are ossifications in the movable flap or gill-cover that projects back from the hyoid arch, and are thus bones of a different category. This exclusion of the preopercular from the opercular series is not a new idea, although independently arrived at, for it is to be noted that Cole and Johnstone (Proc. & Trans. Liverpool Biol. Soc. xvi. 1902, p. 175), in describing the osteology of the Plaice, have pointed out that the preopercular is a bone developed primarily around a portion of the lateral-line system, and is therefore of a different nature from the other opercular bones. On page 177 they classify the preopercular with the lachrymal, nasal, suborbital and supra-temporal bones, a step which I am fully prepared to endorse.

The determination of the morphological value of the interopercular bone is not an easy matter. On examining the skull of *Amia* it is difficult to believe that the interopercular does not belong to the same series as the opercular and subopercular bones, and yet in *Lepidosteus* the interopercular is quite removed from the subopercular, and is situated at the front of the lower or horizontal limb of the preopercular bone. Possibly the name interopercular has been applied in different fishes to bones of different morphological value. However, on the separation of the preopercular from the opercular and branchiostegal series of bones and the introduction of it into the temporal series, it becomes necessary to decide whether the interopercular belongs to the one or the other of these groups, and on the whole I am disposed to regard it as more closely related to the preopercular than to the subopercular and opercular bones.

This is not the view taken by Cole and Johnstone, who consider (Proc. & Trans. Liverp. Biol. Soc. xvi. 1902, p. 175) that the not infrequent articulation between the interopercular and the epihyal confirms the view that the interopercular, like the opercular, is a modified branchiostegal ray.

The ligamentous connection so commonly met with between the front of the interopercular and the back of the mandible is probably merely adaptive, and does not point to any morphological relation existing between this bone and the mandibular arch. The question is discussed by Gegenbaur (Morph. Jahrb. iv. Suppl. 1878, pp. 15 & 16, footnote).

* To be strictly logical, such bones as the squamosal should also be classed as sensory-canal bones of the temporal series; but it is clearly more expedient to regard them as component parts of the "cranium."

It might reasonably be urged that the interopercular is a bone of the true opercular series which has been squeezed out of its primitive position between the subopercular and the last branchiostegal ray, in much the same way as the penultimate member of the branchiostegal-opercular series has been reduced and forced out of its position in the Palæoniscid fishes. The bone in question was originally regarded by Traquair ("Ganoid Fishes Brit. Carb. Form.," Palæontogr. Soc. 1877, p. 20) as the subopercular, but subsequently (*ibid.* 1901, p. 62) as an accessory plate. Smith Woodward appears to regard it as the interopercular (Brit. Mus. Cat. Foss. Fish. ii. 1891, p. 487). But, whatever may be the homology of the bone, the evidence that it has been excalated and finally lost is tolerably clear. In Teleosteans, however, there is no evidence available to show that any such displacement of the interopercular has taken place; even in *Pholidophorus*, the lowest of the Teleostean series, the interopercular already occupies its definitive position in advance of the subopercular.

In that very aberrant genus *Phractolemus*, the preopercular is small and the interopercular remarkably large. The latter bone is situated below and anterior to the preopercular, and receives from it the sensory canal that descends from the squamosal. The interopercular is thus here performing the function of the missing horizontal limb of the preopercular. In no other case have I seen the interopercular conveying a sensory canal; in the vast majority of cases the interopercular is a thin lamina of bone which is almost entirely concealed by the lower part of the preopercular. The evidence for putting the interopercular with the preopercular is unsatisfactory, but owing to the perfect manner in which the branchiostegal rays grade off into the subopercular and opercular, there is no justification for including it with these last as a constituent of the skeleton of the gill-cover.

The interopercular is of very regular occurrence, but it is said to be wanting in *Pantodon*. As regards the preopercular, it may be taken as a general rule, not however without exception, that the horizontal limb of this bone is most developed in those forms with a greatly reduced mouth, e. g. *Gonorhynchus* and *Chanos*, and absent in those with a very large gape, e. g. *Engraulis* and *Coilia*. In *Albula* and *Alepocephalus* the vertical and horizontal limbs are nearly equal.

Circumorbital and Nasal Series.—No results of any great morphological importance are to be expected from a comparative study of the bones of the circumorbital series. They are probably more subject to variation—generic, specific, and individual—than any other bones of the skull; and the number of the bones surrounding the orbit is not infrequently found to differ on the right and left sides of the same skull.

In *Arapaima*, *Heterotis*, and *Osteoglossum* the enlargement of the nasal bones, their meeting in a median suture, and their rigid union with the cranial bones, are features which are not encountered in any of the other genera under examination. The

nearest approach to such a condition is found in *Notopterus*, in which the two nasals are fairly large, and just meet in the middle plane of the head, and are with some difficulty removable from the underlying mesethmoid and prefrontal bones. A very similar condition obtains in *Petrocephalus*, in which the nasal bones are exceptionally large.

The postorbital cheek-plates are large in *Arapaima*, *Osteoglossum*, *Hyodon*, *Elops*, and *Megalops*. Both postorbital and suborbital bones are large in *Albula*. In *Chirocentrus* the bone lying antero-ventral to the orbit is large. There is one large suborbital, extending also behind the eye, in *Chanos*, *Engraulis*, and *Clupea harengus*, but in *Clupea finta* the postorbital part of the cheek is protected by two large plates. In some forms, such as *Coilia*, *Albula*, and *Notopterus*, in which the postorbital and suborbital sensory canals are large, the bones have a scroll-like form; but in the other genera the sensory canal lies farther from the orbital edge of the circumorbital bones (e. g., *Clupea*, *Chatoëssus*), or is more deeply embedded in the bone (e. g., *Arapaima*, *Chanos*).

In *Notopterus* there are processes of the two hindermost of the suborbital bones directed inwards below the eyeball towards the ectopterygoid and entopterygoid, with which they are united by ligament. There is also a process passing inwards from the anterior end of the front suborbital bone, and entering into close fibrous union with the under surface of the prefrontal. Boulenger finds that in some families of the Perciform fishes the "subocular shelf" is sufficiently constant to be of taxonomic value (Ann. & Mag. Nat. Hist. (7) xiii. 1904, p. 179).

In this connection it is interesting to note that in *Albula* and in *Dussumieria* there is an outwardly-directed process of the ectopterygoid, underlying the eyeball, which meets the edge of the suborbital bones. This process, like the subocular shelf, serves the purpose either of supporting the eyeball, or of limiting the lateral play of the series of suborbital bones.

In *Osteoglossum* there is a close fibrous connection between the maxilla and the preorbital and suborbital bones, but this is not the case in *Heterotis* and *Arapaima*.

Maxillary Series.—The evidence of palæontology goes to show that the most primitive form of mouth is that bounded above by a small premaxilla and a comparatively long maxilla; at all events, an enlarged premaxilla has not yet been noted in Iso-spondylous fishes below the Cretaceous strata (Smith Woodward, Vert. Palæontology, 1898, p. 113). Most of the forms now under examination have a premaxilla-maxillary gape; but in *Albula*, in which, according to Jordan and Gilbert (Bull. U.S. Nat. Mus. No. 16, 1882, p. 258) and Smith Woodward (Brit. Mus. Cat. Foss. Fish. iv. p. 59), the lateral margin of the upper jaw is formed by the maxilla, the maxilla can be of service only when the mouth is widely opened, and indeed, since it bears no teeth, while the premaxilla does, it probably does not function in

prehension at all. A similarly constituted mouth occurs in the Mormyridæ. The right and left premaxillæ of Mormyroid fishes are fused, and the suture obliterated (except in *Gymnarchus*). A similar condition is said to exist in *Pantodon*. In *Chanos*, *Chatoëssus*, and *Gonorhynchus* the premaxilla alone bounds the gape above, and is devoid of teeth.

The exceptional, and apparently useless, backward prolongation of the maxilla of *Coilia* is a well-known feature of that genus, and claims but a passing mention.

There are two surmaxillæ above each maxilla in *Coilia*, *Engraulis*, *Clupea*, *Dussumieria*, *Chirocentrus*, *Elops*, *Megalops*, and *Alepocephalus*, one in *Chatoëssus* and *Albula*, and none in *Chanos*, *Arapaima*, *Heterotis*, *Osteoglossum*, the Mormyridæ, *Hyodon*, *Notopterus*, and *Gonorhynchus*. Two surmaxillæ are present in the Mesozoic families Pholidophoridæ, Leptolepidæ, and Oligopleuridæ.

Mandibular Series.—The angular bone is distinct in *Arapaima*, *Heterotis*, *Osteoglossum*, *Notopterus*, and most Clupeoids, but not in *Coilia* and *Engraulis*, nor in the Mormyridæ, *Hyodon*, *Albula*, *Elops*, and *Megalops*. In *Notopterus* the angular is a much larger bone than usual. The endosteal and ectosteal parts of the articular bone are distinct and separable in *Arapaima*; and, according to Hay (Zool. Bull. ii. 1, 1898, p. 37), they are also distinct in the Cretaceous genus *Xiphactinus*. He shows that Cope's interpretation of the mandibular bones of this form was entirely erroneous. Since the remark of Owen's (Anat. of Vert. i. 1866, p. 123), that in *Arapaima* there is a superadded bony piece answering to the surangular of Reptiles, is credited by so recent a writer as Smith Woodward (Brit. Mus. Cat. Foss. Fish. iii. 1895, p. xix), it may be well to point out that this superadded bone, marked 29 *a* in Owen's fig. 88, is but the endosteal articular displaced. In *Gymnarchus*, *Hyodon*, *Albula*, *Elops*, and *Megalops* the endosteal and ectosteal components of the articular would probably separate with prolonged maceration, for the suture between them is clearly visible, but I was unable to submit the material in hand to such treatment. As a rule the suture is not visible in Teleostean fishes.

In some forms the posterior part of the surface for the articulation with the condyle of the quadrate is formed by the angular, the part of the angular bone concerned having a distinctly endosteal appearance. Such is the case in *Gonorhynchus*, *Arapaima*, *Albula*, *Megalops*, *Elops*, *Gymnarchus*, *Hyodon*, and *Heterotis*, but in *Osteoglossum*, *Notopterus*, and the Clupeidæ the articular facet is formed by the endosteal articular alone. In *Notopterus* and the Clupeidæ the angular bone has the appearance of an ectosteal bone.

Except in a few forms (e.g., *Arapaima*, *Petrocephalus*, *Engraulis*, *Chatoëssus*, *Dussumieria*) there is a distinct bone lying usually in front of the endosteal articular and on the inner (lingual) surface

of the ectosteal articular, and developed above or around Meckel's cartilage. This gives attachment to the tendon of a part of the levator muscle of the mandible, and may be called the "sesamoid articular," thus making a third component of the articular bone. Vetter (Jena. Zeitschr. xii. 1878, pl. 13. fig. 8, *Ss.*) has called attention to this bone in the Pike as a "Sesamoidverknöcherung an der Insertion der Endsehne von $A_3-A_3^t$ an Meckel'schen Knorpel," A_3 being his third or deep portion of the adductor mandibulæ, and A_3^t its tendon.

This sesamoid articular is remarkably large in *Albula* (text-fig. 17, p. 50), *Gymnarchus*, and *Hyodon*, in which it is set on the antero-superior side of the endosteal articular. It is of fair size in *Notopterus*, *Osteoglossum*, and *Gonorhynchus*; but as a rule it is small, and is situated just in front of the endosteal articular (e. g., *Heterotis*, *Clupea*), or at a short distance in advance of it (e. g., *Elops*, *Megalops*).

The sesamoid articular was described in 1878 in the mandible of *Belone* as a "coronoid bone" by Cope (Proc. Amer. Phil. Soc. xvii. p. 695), who was of opinion that the bone occurred in no family of Teleostean fishes except the Belonidæ. Gill, writing in 1895, described the bone in question as "lying mostly inside of the upper portion of the dentary" (Proc. U.S. Nat. Mus. xviii. 1895, p. 173), and, admitting that it was not in any way homologous with the coronoid of *Lepidosteus*, proposed to call it the "addentary" (*l. c.* p. 174). The relation of this bone to the dentary was, however, based upon an error on the part of Dr. Gill. He writes (*l. c.* p. 173):—"This element appears to have been unnoticed by most naturalists, and to have been first observed by Dr. B. C. Brühl. In 1847 Brühl (Anfangsgründe der vergl. Anat. aller Thierklassen, Atlas, pl. xi. fig. 17) published a figure of the disintegrated right mandible in which the supplementary bone is marked ZK. I have, however, been unable to find any reference to it in the text." As a matter of fact, only two of the four bones figured by Brühl are those of the mandible, the other two are parts of the upper jaw, and are marked ZK and OK, which abbreviations are explained on p. 88 of the text as standing for 'Zwischenkiefer' and 'Oberkiefer' respectively.

The sesamoid articular has been minutely studied by Prof. Starks, who in a letter to me dated March 15, 1904, states that it is a small ossicle situated on the inner surface of the articular, just above Meckel's cartilage, that it occurs at the lower end of the ligament (? tendon) which is attached to the articular, and that it occurs much more commonly than is generally supposed. In 1900 he published (Proc. U.S. Nat. Mus. xxii. 1900, p. 2, footnote) a list of eighteen genera of Teleostean fishes in which he had detected the presence of this "coronoid bone."

Although teeth occupying the position of splenial teeth, and referred to as such by Owen (Anat. of Vert. i. 1866, p. 123), occur in the mandible of *Arapaima*, no separate splenial is to be found in any of the fishes examined, which, being the lowest of

the Teleostean series (excluding extinct forms such as the Pholidophoridae, in which "it is not yet quite clear that the mandible was destitute of splenial and coronoid elements" (Smith Woodward, Vert. Palæontol. 1898, p. 114), might more than any others be expected to possess traces of this constituent.

The size and shape of the dentary bone vary very considerably. The bone is usually large; but it is much reduced, especially in its anterior parts, in *Chanos*. The coronoid process is usually formed entirely by the dentary, but the ectosteal articular occasionally forms the hinder part of it. In *Chatoëssus* the process is situated unusually far forward, in a position recalling that of the remarkable coronoid process of *Gonorhynchus*.

In the extinct family Saurodontidae the teeth are lodged in sockets; and Boulenger, in his recent synopsis of the families of Teleostean fishes (Ann. & Mag. Nat. Hist. xiii. 1904, p. 164), places the Chirocentridae next the Saurodontidae, and separates them from the Clupeidae because they have "teeth in sockets." The teeth of the three specimens of *Chirocentrus dorab* examined for the purposes of this investigation are, however, certainly not lodged in sockets; they are ankylosed to the edge of the bone, and are flanked by a slight ledge on the external side, exactly as in *Coilia*, for instance.

Hyopalatine Series.—The presence of one or two articular heads for the front of the hyopalatine arch, a matter upon which Swinnerton (Quart. Journ. Micro. Sci. xlv. 4, 1902, pp. 551, 556–557, & 584) lays considerable stress, may possibly be an adaptive feature related to the length of the ethmoid region of the skull, for in *Elops* and *Megalops* the ethmoid region is short, and the front of the hyopalatine arch has but a single head, whereas in *Albula* the ethmoid region is long and there are two heads to the palatine. The difference does not strike one at the outset as likely to be of fundamental importance: extended investigations upon dissected, *i. e.* not dried, skulls alone can decide the point. An unusual condition occurs in *Coilia*, in which the ethmoid region of the cranium is short and the palatine has two heads; but these are right and left, and not anterior and posterior. This peculiarity is not shared by the allied genus *Engraulis*.

The palatine bone is fused with the ectopterygoid in *Arapaima*, *Osteoglossum*, and *Notopterus*, and in these genera and in *Hyodon* there appears to be no endosteal part of the palatine. In the Mormyroid fishes there is no separate entopterygoid, and the palatine bone is fused with the side of the vomer.

The metapterygoid attains its maximum size relatively to the adjacent bones in *Coilia*; in *Gonorhynchus* the other extreme is reached, for here it is reduced to a fine needle of bone. The articulation between the metapterygoid and entopterygoid region of the hyopalatine arch of *Osteoglossum* and the lateral process of the parasphenoid described by Bridge in 1895 (Proc. Zool. Soc. 1895) is considered by Swinnerton (*l. c.* p. 572) on embryological

grounds to be a primitive articulation persisting in this case, but lost in the great majority of Teleostean fishes. Such an articulation also exists in *Arapaima* and *Heterotis*. In the Mormyroid fishes the whole of the upper edge of the hyopalatine arch enters into extensive relation with the under surface of the cranium.

The symplectic is usually rod-like, but in *Arapaima*, and to a less extent in *Osteoglossum* and *Notopterus*, it spreads in a squamous manner over the surrounding bones. It is wanting in the Mormyridæ. The slope of the hyomandibular varies considerably in the different genera, as also does the angle which the symplectic makes with the axis of the hyomandibular. The ectopterygoid is in some cases straight (e. g. *Hyodon*), in others moderately bent (e. g. *Clupea*) or sharply angulate (e. g. *Chatoëssus*).

The hyomandibular articulates with the cranium by either one or two heads; and since two species of the same genus may vary in this respect, one may conclude that no great importance need be attached to the difference. The hyomandibular of *Clupea finta* differs from that of *Clupea harengus* in possessing two separate heads for articulation with the cranium, whereas the latter has a single head, broad antero-posteriorly. Since Swinerton (*l. c.* pp. 541, 544, & 549) has shown that in the development of *Gastrosteus* the double head of the hyomandibular results from the enlargement of the anterior and posterior ends, and the reduction of the middle part, of a single broad head, *Clupea harengus* may possibly be more primitive than *Clupea finta* in this respect.

One would imagine on general grounds that a diminution in the size of the mouth would be associated with a forward slope of the hyomandibular, a marked angulation between the symplectic and the hyomandibular, and a sharp bend in the middle of the ectopterygoid; and this is certainly what one finds in *Chatoëssus*, and to a lesser extent in *Clupea harengus* as compared with *Clupea finta*. Yet, while *Megalops* has a smaller mouth than *Elops*, its symplectic is more nearly in a line with the hyomandibular than in the latter genus; that is to say, the angle, as measured in degrees, is greater (*cf.* text-figs. 14 & 10, pp. 46 & 40). The angulation of the ectopterygoid is approximately the same in both, and the advancement of the quadrate articulation in *Megalops* is brought about by the forward slope of the hyomandibular only. *Hyodon* has a fairly large mouth, associated with a perfectly straight ectopterygoid and a backwardly sloping hyomandibular, yet, as in *Elops*, the symplectic is strongly bent upon the hyomandibular. Somewhat similar relations—the symplectic angle, however, being more open—obtain in the large-mouthed genera *Engraulis* and *Coilia*. On the other hand, it is interesting to note that in the small-mouthed forms *Gonorrhynchus* and *Chanos* the hyomandibular does not slope forward. In the latter genus the quadrate has shifted forward along the ectopterygoid, and has parted from the symplectic entirely.

In *Chirocentrus*, although the mouth is fairly large, the quadrate is advanced by a forward rotation of the hyomandibular. The symplectic in this case is in a direct line with the axis of the hyomandibular. In *Arapaima* the mouth can hardly be described as small, yet the forward slope of the hyomandibular is excessive. The explanation of this is most probably to be sought in the great length of the postorbital portion of the head.

In *Engraulis* and *Coilia* alone of the forms under consideration does the quadrate slope backward.

Opercular Series.—The reasons for excluding the preopercular and interopercular bones from this series are given on p. 68. The bones considered under the present heading are the opercular and subopercular bones, the branchiostegal rays and the jugular plate.

As is well known, the subopercular bone is wanting in *Notopterus*. This condition is unparalleled among the other forms under consideration, although the subopercular is distinctly small in *Osteoglossum* and *Arapaima*, and very small in *Heterotis*. It is comparatively large in *Albula* and *Gonorhynchus*; it is said to be wanting in *Pantodon*.

The lower Malacopterygian fishes are well adapted for demonstrating the continuity of the opercular and branchiostegal systems. The opercular and branchiostegal bones are functionally similar, serving to support the gill-cover, and there seems to be good reason for regarding them as morphologically similar also. The view is by no means a new one, for Traquair ("Ganoid Fishes Brit. Carb. Form.," *Palæontogr. Soc.*) demonstrated it in the case of the *Palæoniscidæ* in 1877, and Shufeldt (*Rep. U.S. Com. Fish.* 1883 (85), pp. 818 & 820) mentioned it in 1883; and although the latter does not in his paper give references to previous expressions of such opinion, he does not himself claim the idea as original. The only recent reference to such a view appears to be that by Cole and Johnstone (*Proc. & Trans. Liverp. Biol. Soc.* xvi. 1902, p. 175), who mention the opercular bones (excepting the preopercular) as "modified branchiostegal rays."

In *Chanos*, *Albula*, and *Elops* the transition from the uppermost branchiostegal rays to the subopercular and opercular bones is very evenly graduated, and in *Osteoglossum* it becomes a matter of some difficulty to decide whether the bone lying antero-ventrally to the opercular is a reduced and displaced subopercular, or the uppermost branchiostegal ray which has lost its connection with the epihyal. The difficulty of deciding whether a bone lying below the opercular bone is a subopercular or a free branchiostegal ray, the true subopercular being wanting, must frequently have occurred to the systematic ichthyologist. Boulenger distinctly admits the difficulty when dealing with the Mormyroid fishes ('*Poissons du Bassin du Congo*,' 1901, p. 50, footnote). In preparing the skull of *Engraulis* the subopercular comes away readily with the epihyal, and is very liable to be mistaken for a

branchiostegal ray, a fact already pointed out by Valenciennes (Hist. Nat. Poiss. xxi. 1848, p. 11).

Incidentally it may be pointed out as an item of evidence in favour of regarding the hyomandibular as an element of the hyoid arch, a view which Pollard has contested*, that there is invariably a definite articulation between the front of the opercular bone and a special process from the back of the hyomandibular, comparable with the less definite articulation between the antero-superior extremities of the branchiostegal rays and the epihyal and ceratohyal.

It is generally assumed, and the results of the present investigation tend to show that the assumption is justifiable, that a large number of branchiostegal rays is a primitive character. The greatest number of rays occurs in *Elops*, which has from 30 to 35 on each side; *Megalops* has about 24; and *Engraulis*, *Coilia*, and *Dussumieria* from 10 to 13. *Albula* has 15, but the allied deep-sea genus *Bathythrissa* only possesses 6. The commonest numbers are from 6 to 9: *Chanos* and *Gymnarchus* have as few as 4.

The jugular plate present in *Elops* and *Megalops* is not definitely related to the hyoid arch, but, on the contrary, is united by ligament with the mandibular symphysis. Functionally, at all events, the jugular plate belongs to the branchiostegal series, and it is more convenient to treat it under this heading than elsewhere. Parker's recognition of the urohyal as a basibranchiostegal is altogether erroneous. The urohyal is never superficial and does not support the gill-cover; it is an ossified tendon of the lingual retractor muscles (see "Hyobranchial Series" below).

Hyobranchial Series.—The unfortunate application by Parker (Phil. Trans. vol. 163. 1873 (1874), p. 101) of the name "basibranchiostegal" to the urohyal bone has occasioned much confusion, and in spite of the unsuitability of the term it continues to be employed by certain writers, and appears in a paper published as recently as 1901 (Supino, Ric. Lab. Anat. Univ. Roma, viii. 3, 1901, p. 18). Even if the urohyal could be shown to belong to the branchiostegal series, the prefix *basi-* would be misleading as implying homology with the component parts of the copular skeleton, for the branchiostegal rays are dermal, not visceral bones. As a matter of fact, the urohyal is an ossified tendon, or an ossification of the intermuscular septa, as Parker himself admitted, lying between the two sternohyoid muscles†, and is

* Anat. Anz. x. 1895. By his describing the Teleostean skull as *metautostylic* (p. 25) I conclude he regards the hyomandibular as a part of the mandibular arch; at all events he considers the hyomandibular of the Teleostean to be homologous with the prespiracular cartilage of Sharks, which, from its position in front of the spiracle, is undoubtedly a constituent of the mandibular and not of the hyoid arch.

† Gegenbaur (Morph. Jahrb. iv., Suppl. 1878, p. 17) writes:—"Er dient, wie sonst, zur Insertion der subbranchialen Muskulatur, und hat weder zur Membrana branchiostega noch zu den Kiemenbogen irgend eine Beziehung." See also Vetter, Jena. Zeitschr. xii. 1878, pl. xiii. fig. 10, *Stk.* Günther ('Study of Fishes,' 1880, p. 91) says that the urohyal "separates the muscoli sternohyoidei, and serves for an increased surface of their insertion."

attached by two ligaments to the right and left hypohyal bones, except in the Mormyroid fishes, in which it is rigidly fixed beneath the anterior part of the copular skeleton.

Shufeldt (Rep. U.S. Com. Fish. 1883 (85), p. 820) writes that the urohyal "lies between the sternohyoid muscles, and is not always present where a glossohyal exists." The latter part of the quotation is, I think, open to serious question; it is probably always present in Teleostean fishes. Brooks (Proc. Roy. Dubl. Soc. n. s. iv. 4, 1884, pp. 180-183), in his description of the skull of the Haddock, while adopting the name basibranchiostegal for this tendon-bone, misapplies the term urohyal to that cartilage which lies between the last two pairs of ceratobranchials, and represents the fourth and fifth basibranchials.

In connection with the urohyal, it is of interest to observe that in *Notopterus* there are, in addition to the urohyal proper, a pair of tendon-bones of similar character to it, but of smaller size, projecting backwards from the posterior end of the ventral surface of the second basibranchial. Such tendon-bones are also present in *Osteoglossum*, *Heterotis*, and the Mormyridæ; but in these fishes they are confluent with the reduced second hypobranchials. In dealing with the homologies of tendon-bones, one must ever be prepared to admit the possibility of convergence; thus, while in *Notopterus* there are separate tendon-bones related to the second hypobranchials and the second basibranchial, in *Diodon* (*Dicotyl-ichthys*) a pair of exactly similar bones project down from the mesial ends of the third ceratobranchials, and represent either the downwardly directed and greatly elongated third hypobranchials, or a pair of tendon-bones confluent with the third hypobranchials, or simply a pair of tendon-bones, the third hypobranchials being absent. In *Polypterus*, again, the urohyal as a median bone is wanting, but a pair of tendon-bones project downward and backward from the ventral surface of the anterior end of the ceratohyal.

The hypohyal of each side of the head is usually double, consisting of distinct upper and lower ossifications. The right and left upper hypohyals are separated by the first basibranchial or the glossohyal, or both, but the two lower hypohyals are articulated together in the median plane. The lower hypohyal in most cases is larger than the upper, but in *Hyodon*, *Elops*, *Megalops*, and *Albula* the upper and lower hypohyals are approximately equal in size. In *Arapaima*, *Heterotis*, *Osteoglossum*, *Petrocephalus*, and *Notopterus* there is but one hypohyal on each side, and this would appear to represent the upper one. This is rather odd when considered in relation with the probability that the single hypohyal of *Amia* represents the lower of the two. In Mormyroids other than *Petrocephalus* no hypohyals are recognisable.

It is difficult to understand why Supino, in his recent work on the skull of deep-sea Teleosteans (Ric. Lab. Anat. Univ. Roma, viii.-ix. 1901-2), and Starks, in his description of the Serranoid

Roccus (Proc. Wash. Acad. Sci. iii. 1901, pl. lxiv.), allude to the hypohyal as the basihyal. Owen (Anat. of Vert. i. 1866, pp. 106 & 124), it is true, used the word basihyal in this sense, and was followed by Günther ('Study of Fishes,' 1880, p. 58) and others; but the homology between the glossohyal of the Teleostean and the basihyal of the Elasmobranch is now so firmly established that there is no justification for reviving an erroneous terminology. What is more incomprehensible than the retention of an obsolete application of the term basihyal is the fact that Starks, while calling the hypohyals the basihyals in 1901 (*l. c.*), designates them hypohyals in 1898 and 1904 (Proc. Calif. Acad. Sci. (3) i. 2, 1898, pl. xxiii. fig. 8, *Sebastolobus*; and Proc. U.S. Nat. Mus. xxvii. 1904, p. 603, Berycoid fishes).

Most writers are in agreement as to the application of the terms epihyal and ceratohyal, but Allis has adopted an unusual nomenclature which appears to have very little to recommend it beyond the fact that it serves to locate the main jointing of the hyoid arch between the epi- and cerato-elements, as occurs in the branchial arches; he regards the epihyal as a part of the ceratohyal (which is, according to his view, a double ossification), and calls the interhyal the epihyal (Journ. Morph. xii. 3, 1897).

The glossohyal or basihyal varies greatly in size, being largest in *Hyodon*, and extremely reduced in *Engraulis* and *Coilia*. There is no separate glossohyal in the Mormyridæ; it is either wanting, or is fused with the first basibranchial. An endosteal glossohyal is frequently present in addition to the ectosteal and usually dentigerous bone (e. g., *Albula*, *Chirocentrus*, *Megalops*), but in such forms as *Heterotis*, *Osteoglossum*, *Chatoëssus*, *Clupea*, and *Alepocephalus* the cartilage remains unossified.

The dentigerous plate which covers the first, second, and third basibranchials is readily removable in *Arapaima*, but in most cases it is fused with the second, and overlaps the hinder part of the first basibranchial and the anterior part of the third basibranchial (e. g., *Clupea*, *Chirocentrus*, *Engraulis*). In *Hyodon* it is fused with the third as well as with the second basibranchial, and in *Albula* it is fused with all three basibranchials, and overlaps, but is not fused with, the posterior half of the glossohyal. It is much reduced in size in *Chatoëssus*, in which it is edentulous; and in *Gonorhynchus* it is confined to the second basibranchial. In *Dussumieria* each of the three basibranchials has its own dentigerous investing bone. There is in most cases also a much smaller dentigerous bone covering the plate of cartilage that represents the fourth and fifth basibranchials.

The first basibranchial is unossified in *Heterotis*, *Notopterus*, and *Gonorhynchus*. The second basibranchial is remarkably long in *Engraulis*, and the parallelism of the first and second ceratobranchials is much disturbed in consequence. In *Chanos* the anterior ends of the fourth and fifth ceratobranchials are separated by a narrow, elongated tract of cartilage; in *Alepocephalus* and *Chatoëssus* the anterior ends of the third and fourth cerato-

branchials are set close together, without the usual interval. The fourth and fifth basibranchials are represented by an undivided plate of cartilage, as is customary in Teleostean fishes. No trace of ossification is to be detected in this plate, a fact which is of interest in relation to the discovery by Swinnerton of separate ossified fourth and fifth basibranchials in that aberrant and specialised genus *Cromeria* (Zool. Jahrb., Abth. f. Anat. xviii. 1903, p. 66).

The hypobranchials are much reduced in the Mormyroids, and, as already pointed out, the second hypobranchials are confluent with prominent tendon-bones. In *Coilia* and *Engraulis* the second hypobranchials are fused with the sides of the second basibranchial, and in *Chanos* the third hypobranchials are fused with the third basibranchial, but in each case the suture remains visible.

The "spicular bone" is generally taken to represent the modified first pharyngobranchial. In *Hyodon* the first pharyngobranchial bone is large, and is certainly upturned and rod-like, resembling a spicular bone; but in all the forms examined which have a true spicular bone this arises from the upper surface of the first epibranchial, and not from its anterior end as it does in *Hyodon*. In *Chirocentrus* the first pharyngobranchial is a conical bone projecting forward and upward. In *Albula* it is a bone which runs forward with its axis in a line with that of the first epibranchial, and is clearly serially homologous with the second and third pharyngobranchials. In *Mormyrus* and *Mormyrops*, also, there is a small ossified first pharyngobranchial, but as a rule this element of the visceral skeleton is cartilaginous.

The above-mentioned genera appear to have no true spicular bone, but in *Engraulis*, *Clupea*, *Chatoëssus*, and *Chanos* there is a cartilaginous first pharyngobranchial and a true spicular bone in addition, while in *Elops*, *Megalops*, and *Alepocephalus* there is a well-defined and fully ossified first pharyngobranchial as well as a slender spicular bone. The simultaneous presence of a spicular bone and an unmistakable first pharyngobranchial bone effectually disposes of the argument that the spicular bone represents a modified first pharyngobranchial. The spicular bone has the value of an ossified ligament for the attachment of the branchial skeleton to the side of the pro-otic, and is not a primary constituent of the visceral skeleton. The confusion which has arisen with respect to it, is probably due to the fact that in some cases—it is not yet possible to say whether they are many or few—the first pharyngobranchial takes upon itself the suspensory function of the real spicular bone. The long bone which in the Berycidæ and Cyttidæ is attached to the anterior end of the first epibranchial appears to be a true first pharyngobranchial, but further observations upon the relations and the development of this bone are much to be desired.

It is frequently difficult to say whether a bone of the branchial skeleton is really toothed or not, since in cases where teeth are

present they may be fused to the bone, or may strip off with the mucous membrane, and leave no scar upon the surface of the bone. The matter is of some little importance because the mucous membrane is customarily allowed to dry on the pharyngeal skeleton to prevent the constituent parts from separating, and loose teeth thus appear as if they were rigidly attached. The dentigerous plates on the fifth ceratobranchial are readily removable in *Elops* and *Megalops*, which is rather remarkable, for the teeth of the fifth ceratobranchial are usually firmly fixed to the bone even in those cases in which there is considerable reduction in the hyobranchial dentition as a whole. It is worthy of remark in connection with the probable origin of the ectosteal constituent of the glossohyal by the coalescence of tooth-bases (*cf.* vomer, &c., p. 63), that in the Herring the glossohyal is a cartilage overlaid by the ectosteal lamina; and the teeth, although they may leave scars on the bone when the mucous membrane is stripped off, are not intimately attached to the bone. This evidently indicates a process of degeneration in the lingual dentition, the first stages in the transition to an edentulous state being marked by a reduction of the basal parts of the teeth.

The dentigerous plates lying on the pharyngeal surface of the second, third, and fourth pharyngobranchials are not collected together to form an epipharyngeal apparatus as, for instance, in the Cod, but they remain distinct. The cartilage of the fourth pharyngobranchial remains unossified, but in some forms, such as *Albula* and *Chirocentrus*, the cartilage in drying shrinks upon the underlying dentigerous plate in such a way as to give the impression that itself is ossified. In *Chatoëssus* the ectosteal bone, here toothless, spreads over the mesial and dorsal surfaces of the cartilage, and gives the effect of a completely ossified fourth pharyngobranchial. Swinnerton, it may be mentioned, has recorded the presence of a truly ossified fourth pharyngobranchial in *Cromeria* (Zool. Jahrb., Abth. f. Anat. xviii. 1903, p. 65, figs. H & K).

Engraulis, *Gonorhynchus*, and *Alepocephalus* have a distinct fifth epibranchial cartilage. The presence of this element in *Alepocephalus* was pointed out by Gegenbaur, who has also figured one in *Clupea alosa* (Morph. Jahrb. iv. Suppl. p. 24, and pl. 2. fig. 13, *Alosa vulgaris* or *Clupea vulgaris*). In *Clupea harengus* and *C. finta* the position of the fifth epibranchial is occupied by a ligament; in most genera there is no representative of this element of the visceral skeleton.

The epibranchial accessory organ of respiration produces, in those Malacopterygians in which it is at all largely developed, important modifications in the shape and size of the elements of the fourth and fifth branchial arches. In *Chatoëssus*, and to a lesser extent in *Chanos*, the fifth ceratobranchial and the fourth epibranchial are considerably increased in width, but in *Gonorhynchus* these bones are only lengthened. For our knowledge of the structure of the epibranchial organ of Clupeoid fishes we are

mainly indebted to Hyrtl (Denkschr. Akad. Wiss. Wien, x. 1855, pp. 47-57, and xxi. 1863, pp. 1-10).

The epibranchial organ is by no means confined to these fishes, but occurs, in one form or another, in *Hypodon*, in *Heterotis* (Hyrtl, Denkschr. Akad. Wiss. Wien, viii. 1854, pp. 73-88), in certain Characinoid fishes (Hyrtl, Denkschr. Akad. Wiss. Wien, xxi. 1863; Kner, Verh. zool.-bot. Ges. Wien, xi. 1861, pp. 189-192; Sagemehl, Morph. Jahrb. x. 1885, p. 114), in *Osphromenus*, *Anabas*, &c. (Cuv. et Val., Hist. Nat. Poiss. vii. 1831, p. 328 and pl. 206; Peters, Müll. Arch. Anat. Phys. 1853, pp. 427-430), and probably in several other forms not related to the above-named genera. In the last instances given, the whole of the epibranchial and pharyngobranchial skeleton is modified, while the fifth ceratobranchials remain unaltered.

Abbreviations employed in the Figures.

<i>al</i> , alisphenoid.	<i>mpt</i> , metapterygoid.
<i>an</i> , angular.	<i>mx</i> , maxilla.
<i>bb</i> , dentigerous plate covering the basibranchials.	<i>n</i> , nasal.
<i>bo</i> , basioccipital.	<i>op</i> , opisthotic.
<i>br</i> , branchiostegal rays.	<i>opc</i> , opercular.
<i>bs</i> , basisphenoid.	<i>or</i> , orbitosphenoid.
<i>cb</i> , ceratobranchial.	<i>p</i> , parietal.
<i>ch</i> , ceratohyal.	<i>pb</i> , pharyngobranchial.
<i>cor</i> , circumorbital bones.	<i>pl</i> , palatine.
<i>ct</i> , cartilage.	<i>pm</i> , premaxilla.
<i>d</i> , dentary.	<i>posf</i> , postfrontal.
<i>eb</i> , epibranchial.	<i>pop</i> , preopercular.
<i>ecar</i> , ectosteal articular.	<i>prf</i> , prefrontal.
<i>ecp</i> , ectopterygoid.	<i>pro</i> , pro-otic.
<i>eh</i> , epihyal.	<i>ps</i> , parasphenoid.
<i>enar</i> , endosteal articular.	<i>pt</i> , post-temporal.
<i>enp</i> , entopterygoid.	<i>ptf</i> , posterior temporal fossa.
<i>eo</i> , exoccipital.	<i>q</i> , quadrate.
<i>ep</i> , epiotic.	<i>sar</i> , sesamoid articular.
<i>f</i> , frontal.	<i>sm</i> , surmaxilla.
<i>gh</i> , glossohyal.	<i>soc</i> , supraoccipital.
<i>hb</i> , hypobranchial.	<i>sop</i> , subopercular.
<i>hh</i> , hypohyal.	<i>sp</i> , spicular bone.
<i>hm</i> , hyomandibular.	<i>sq</i> , squamosal.
<i>ih</i> , interhyal.	<i>st</i> , supratemporal.
<i>iop</i> , interopercular.	<i>stf</i> , subtemporal fossa.
<i>me</i> , mesethmoid.	<i>sy</i> , symplectic.
	<i>v</i> , vomer.

May 17, 1904.

HOWARD SAUNDERS, Esq., F.L.S., Vice-President,
in the Chair.

The Secretary read the following report on the additions to the Society's Menagerie during the month of April 1904:—

The number of registered additions to the Society's Menagerie during the month of April was 111, of which 46 were by presentation and 20 by purchase, 20 were born in the Gardens, and 25 were received on deposit. The number of departures during the same period, by death and removals, was 96.

Amongst the additions attention may be called to:—

1. A fine specimen of the Boatbill (*Canachroma cochlearia*), purchased on April 1st.

2. Two Cheetahs (*Cynelurus jubatus*), from the Soudan, presented by Col. B. Mahon, C.B., F.Z.S., on April 18th.

3. Two Keas (*Nestor notabilis*), presented by Mr. T. E. Doune, on April 26th.

Dr. W. T. Calman, F.Z.S., exhibited a specimen of a blind crustacean (*Munidopsis polymorpha*), from a subterranean lake in the Island of Lanzarote, Canaries, collected by Mr. Fairfax Prevost. The species was described in 1892 by Dr. Koelbel, of Vienna, from specimens collected by Prof. Simony, but appears to have been overlooked by recent writers on the group to which it belongs. The lake in which it is found is salt and communicates with the sea, the water rising and falling with the tide. All the other species of the genus, over 100 in number, are inhabitants of the deep sea, none being recorded from a depth of less than about 100 fathoms.

Mr. F. E. Beddard, F.R.S., exhibited the body of an example of the Lizard *Chlamydosaurus kingii* which had died in the Menagerie some years ago, and made the following remarks upon the absence of femoral pores:—

Mr. Boulenger has pointed out (Cat. Lizards Brit. Mus.) that while the Australian Agamidæ with one exception possess femoral pores, these structures, are as a rule, wanting in that family. Among those in which the femoral pores are described, or at least asserted to be present and in definite numbers, is the genus *Chlamydosaurus*. The original describer of the genus, and of the species, Dr. Gray (in King's 'Survey of Australia,' vol. ii. p. 424 *et seq.*), however, observed that it was "destitute of femoral pores." Duméril and Bibron ('Erpétologie générale,' p. 440) make use of the phrase "Des pores fémoraux" as part of their definition of the genus. As this absolute contradiction occurs, I have thought it worth while to exhibit to the Society a male example in which there are certainly no femoral pores fully comparable to those of



C. Crossland, del.

Huth, sc. et imp.

1. NOTODORIS MINOR. 2. TREVELYANA COCCINEA.

3. T. CEYLONICA. 4. T. CROCEA.



J. Crossland, del.

Huth, sc. et imp

1. TREVELYANA BICOLOR. 2. NEMBROTHA CRISTATA.
3. N. AFFINIS. 4. MARIONIA LEVIS. 5. TEETH OF (a) BORNELLA DIGITATA
(b) B. EXCEPTA AND (c) B. SIMPLEX.

such other Agamids as, for example, *Amphibolurus barbatus* (also exhibited). If the specimen exhibited by me be not a mere variation, I can understand how it is that the presence of femoral pores has been asserted by some and denied by Gray. For there are along the thigh a few larger scales which might lead to the inference that they were perforated scales. They are not so, however; and when the skin is reflected no glands can be seen; these always accompany the femoral pores, which are, of course, the external apertures of their ducts.

Mr. Oldfield Thomas, F.R.S., F.Z.S., exhibited, on behalf of the President, a sketch by a Chinese artist of a hind and fawn of Père David's Deer (*Elaphurus davidianus*) from Hainan. Unfortunately the artist had added the antlers of a Peking Stag (*Cervus hortulorum*). The sketch was taken from specimens presented to Mr. E. T. C. Werner, H.B.M. Consul at Hainan. It served to prove that Père David's Deer still survived in Hainan. Whether, however, it was indigenous or imported, remained to be determined. Mr. Lydekker was in communication with Mr. Werner on the subject.

The following papers were read:—

1. On some Nudibranchs from East Africa and Zanzibar. Part V.* By Sir C. ELIOT, K.C.M.G., late H.M. Commissioner for the East African Protectorate, F.Z.S.

[Received March 10, 1904.]

(Plates III. & IV. †)

In my last two papers I treated of the Dorididæ Cryptobranchiata as a group, but no systematic importance is to be attached to the order in which the species now to be described are arranged.

PTERAEOLIDIA SEMPERI.—Since writing my description of this species in my second paper (P. Z. S. March 17, 1903, p. 255), I have read Prof. Bergh's account of *Nossis*, characterised by a lateral ridge similar to that found in some of my specimens ('Opisthobranchiata of Danish Expedition to Siam,' 1899–1900, p. 52), and accordingly carefully re-examined them to see if they should not be referred to this new genus. It appears that they should not. The radula is uniseriate, consistently of 18 teeth, and the same in the specimens which have and those which have not the lateral ridge. It therefore seems clear that the ridge is found in the genera where the radula is uniseriate as well as in those where it is triseriate, and, further, that in alcoholic specimens, at any rate, it may be present or absent in the same species.

* For Part IV. see P. Z. S. 1904, vol. i. p. 380.

† For explanation of the Plates, see p. 105.

NOTODORIS Bergh.

[Bergh, "Neue Nacktschnecken d. Südsee," p. 111, in Jour. d. Mus. Godeffroy, viii. 1875; Eliot, Nudibranchiata in J. S. Gardiner's Fauna and Geography of the Maldiva and Laccadive Archipelagoes, vol. ii. part 1.]

This genus, which is recorded from three parts of the Indo-Pacific, seems allied to *Ægires* and the little-known *Triopella*, with which it forms a small group of phanerobranchiate Dorids characterised by a hard texture, valves or other appendages protecting the gills, and undifferentiated teeth. Both *Ægires* and *Notodoris* have simple unperfoliate rhinophores.

The body of *Notodoris* is hard and rough, often marked with prominent ridges. The frontal veil is large. The branchiæ, and sometimes the rhinophores, are protected by valves. There is no labial armature, and the teeth are hamate with indications of an accessory denticle. Three species have been described, each from a single specimen—*N. citrina* B., *N. gardineri* Eliot, and the present *N. minor*. They are all yellow, differing chiefly in size, shape, and the form of the branchial valves. It is just possible that *N. minor* may be a young and undeveloped form. It is smaller than the others, and superficially resembles a *Phyllidia*. It has no distinct tail, no rhinophore valves, and no longitudinal ridges. The branchial valve is three-lobed and not much subdivided. Possibly the gill is constructed differently from those of other species. Both *N. citrina* and *gardineri* have rhinophorial valves and a body tapering off into a tail: the former has a single dorsal ridge running from the rhinophores to the branchial valve, which is eight-lobed: the latter has four dorsal ridges and a branchial valve three-lobed, with elaborate subdivisions.

NOTODORIS MINOR, sp. n. (Plate III. figs. 1 a–1 g.)

One specimen from Chuaka, east coast of Zanzibar.

The living animal was 13 millimetres long, 5 broad and 4 high. It was light lemon-yellow in colour, with sharply-marked transverse black lines. The flat sole occupied the whole ventral surface. The back was not quite smooth, the yellow parts being really low broad lumps between black depressions. The whole body was very stiff and rigid, superficially resembling a *Phyllidia*. The animal was never seen to move.

In the preserved specimen the yellow has become whitish, but otherwise the shape and markings of the living animal are preserved. The integuments are very hard and full of spicules. There is no trace of any mantle-edge, and the body slopes straight down to the sides of the foot. Over the mouth-parts is a strong rounded frontal veil (figs. 1 a & 1 e), also descending right down to the sides of the foot, and extending laterally about as far as the rhinophores. At the beginning of the posterior third of the body are the three gill-valves (figs. 1 a–1 c). They are not noticeable except in profile, as they lie rather flat, and are not much subdivided. Beneath them lie the gills (fig. 1 d), which appear to

consist of about 27 small tufts, pinnate, bipinnate, or tripinnate according to their size, and spread over three areas corresponding to the valves. Possibly each area represents a separate axis, and the gills should be described as three tripinnate or quadripinnate plumes. But this arrangement cannot be demonstrated with certainty in the preserved specimen, and the living animal never raised the valves at all. The rhinophores are thick, conical, and without a trace of perfoliations; they are retracted into simple holes, provided with neither valves nor raised edges. No oral tentacles and no groove in the anterior margin of the foot could be discovered (fig. 1e).

There is no trace of armature on the labial cuticle. The radula consists of 33 rows, the largest of which contain about 25 teeth on each side of the rhachis. The teeth are transparent and crowded: the innermost are smaller and close over the rhachis; the outermost are longer and show no trace of irregularity. The shape of all is much the same, hamate with a rudimentary denticle under the tip of the hook. They much resemble the teeth of *Notodoris citrina* (Bergh, *l. c.* pl. ix. figs. 39, 40), but are somewhat more erect and hardly ever show indications of more than one denticle (fig. 1g). The glans penis spreads out somewhat as in *Nembrotha*, and appears to be trifid. The lower part is armed with a thick mass of minute blunt spines (fig. 1f).

TREVELYANA Kelaart.

[Kelaart, in *Ann. Mag. Nat. Hist.* 3rd ser. vol. i. p. 257, 1858; Bergh, in *Semper's Reisen*, Heft xi. p. 441, & xvi. 2, p. 850.]

This genus is recorded only from the Indo-Pacific, where it seems to be the commonest representative of the Polyceradæ, being frequent under stones between tides. The animals are limaciform, but some specimens at any rate show indications of a division between the back and sides. The body is smooth, bears no appendages, and is usually of a light bright colour varying from red to white. The branchiæ are rarely less than ten, often numerous, and generally small. There is no labial armature or central tooth. The radula is fairly wide, and composed of hamate or awl-shaped teeth, which are often irregular. The hermaphrodite gland, instead of being spread over the liver, is collected into two globular masses.

Several of the species, *e. g.* the *T. ceylonica* and *T. bicolor* given below, are very imperfectly described by the original authorities, and hence identification is uncertain. It is clear that the whitish forms with yellow lines and spots show considerable variety, but it is hard to say how many of these varieties are specific.

TREVELYANA COCCINEA, sp. n. (Plate III. figs. 2a-2f.)

One specimen, dredged between Shimoni and Wasin at 6-8 fathoms.

The notes on the living animal describe it as the largest species

of *Trevelyana* yet found in East Africa, 3 inches long, and stout in proportion. The colour was bright vermilion, plentifully besprinkled with slightly projecting spots of a deeper shade. The rhinophores and gills were small and deep vermilion in colour.

The preserved specimen has greatly shrunk, and is 25 millimetres long, 14 high, and 11 broad. The colour is dirty white, and no spots or tubercles are visible. There is no trace of tentacles or of a mantle-edge, but the frontal veil is a distinct hard ridge. The foot is grooved in front. The tail is very short. There are 12 small gills set in a circle, bipinnate and in parts tripinnate. The vent is subcentral and not raised.

Though there is nothing that can be called a labial armature, the labial cuticle is strengthened with scattered rods of various shapes. The radula is larger than usual in the genus. It consists of 36 rows, some of which contain as many as 51 teeth, so that the formula is $36 \times 50 + 1.0.1 + 50$, but the rows towards the front are much smaller. The first lateral is large and hamate (fig. 2*a*), sometimes with irregular notches or denticles on the outside of the hook (figs. 2*c* & 2*d*). In several cases the top seemed to be broken off, and the remaining part was bifid or trifid (fig. 2*b*). The other teeth are slender and hamate (figs. 2*e* & 2*f*). In all the teeth the hook is directed forwards, not backwards.

The liver is greyish and not very large. In front of the liver, but quite separate from it and from one another, lie two large spherical hermaphrodite glands with a diameter of about 5 and 7 millimetres respectively. They are yellowish in colour, and the surface is covered with knob-like follicles. The verge is armed with transparent spines. The large pericardium lies in front of the branchiæ, and in the alcoholic specimen is much inflated.

This form is possibly the *Stenodoris rubra* of Pease (Am. Journal of Conch. ii. 1866, p. 206), though, if so, "light red papillæ" is a strange description of the raised spots; but the account given of the animal is not sufficient to admit of identification.

TREVELYANA CEYLONICA Kel. (Plate III. figs. 3*a*–3*c*.)

[Kelaart, Ann. & Mag. of Nat. Hist. 3rd ser. vol. i. p. 257, 1858.]

One specimen from the East Coast of Zanzibar.

The notes on the living animal describe it as about an inch long, creamy white, with bright red dots. The gills were yellow, with bright red lines down their backs; larger and more feathery than is usual in the genus. There was a line of bright red round the edge of the foot.

The preserved specimen is colourless, 15 millimetres long and 6.5 broad. The back is quite smooth, and there is no sign of a mantle-rim. The pericardium forms a large, much swollen prominence. The rhinophores are completely retracted. There are 12 branchiæ set in a circle open behind; one is large and bifid, one is rudimentary. The foot is deeply grooved in front. No tentacles could be discerned.

The buccal mass is rather large, the radula fragile, with a wide rhachis. There are 21 rows in all, some of the longest of which contain 24 teeth on each side. The first tooth (fig. 3 a) is larger than the rest, and projects into the rhachis; it is slightly bent, but hardly hamate. All the first teeth are similar and regular in shape. The base is somewhat wavy and as if hollowed out. The other teeth are awl-shaped, with an irregular and somewhat bifid base (fig. 3 c). The liver is yellowish grey and not very large. In front of it are two hermaphrodite glands, much as in *T. coccinea*, but smaller. The verge is armed with numerous short thorns of very varying shape.

I think this animal is probably Kelaart's *T. ceylonica*, for which the genus was founded, and which appears not to have been described since; but it is difficult to be certain of the identification, as he gives no information respecting the radula. The form and colour agree well, including the red lines on the branchiæ and round the foot. The chief difference is that whereas his specimen has 15-16 pure white branchiæ "set round a large disk," mine had 12 yellow branchiæ set in a circle open behind. But his specimen was nearly twice the size of mine, and probably the larger individuals develop extra plumes which close up the posterior gap. On the other hand, both specimens agreed in having rather large feathery branchiæ, an unusual character in the genus. Kelaart says "they resemble a small tuft of marabout feathers."

TREVELYANA CROCEA B. (Plate III. fig 4.)

[Bergh, in Semper's Reisen, xvi. 2, p. 850, figs.]

More than 100 specimens from the East and West Coasts of Zanzibar, where it is one of the commonest littoral molluscs at certain seasons.

Mr. Crossland, who collected them, informs me that this form provided a most striking case of the migration of molluscs in flocks to shallow water for the deposition of spawn.

But few specimens were collected before a certain period of a few days' duration, when the sand of Chuaka Bay just below low-tide mark was occupied by astonishing numbers of these delicate little nudibranchs. These were not washed up by accident, but were all actively crawling on the sand among the weeds &c. Many were *in coitu*, and when placed in basins of sea-water most of the specimens were soon engaged in copulation or the deposition of yellow egg-ribbons. By-and-by the swarm disappeared to some unknown permanent habitat. If this were in the deeper channels of the bay (1 to 2 fathoms deep at low tide) they must have been found there by dredging. As this was not the case, it seems most probable that the migrations of these tiny animals extend to and from the deep sea three or more miles away. An almost equally conspicuous swarm was formed by individuals of *Melibe jimbriata*, and other species (e. g. *Ceratosoma cornigerum*, *Chromodoris* spp., and *Pleurobranchus delicatus*) appeared occasionally for a few days in considerable though

smaller numbers, being rare or completely absent from the shore of the Bay at other times.

Most of the animals were of a bright dark yellow with the black liver showing more or less conspicuously through the transparent integuments, but the colour ranges in exceptional cases from deep orange to almost colourless transparency. Many specimens were infested with small light yellow copepoda found adhering to the body, especially on and near the gills.

The alcoholic specimens are of a more or less yellowish white. The largest is 29 millimetres long, 12 high, and 8 broad, but, as a rule, the back is proportionately broader. The whole body is smooth and very soft. In most specimens the dorsal area is bounded by a distinct lateral ridge. It is not visible behind the branchiæ, but extends from them to the front of the head, where, however, it is not continuous but divided by a deep notch in the middle. In several specimens this ridge is only clear in places and in a few it is absent altogether. The rhinophores bear about ten perfoliations and are set in such shallow pits that they can hardly be called retractile. They are exposed in the alcoholic specimens. The edges of the pits are smooth. The gill consists of from 20 to 34 leaflets*, set in a horseshoe or circle open behind, and placed rather far back. The leaflets are flat and compressed and decrease in size posteriorly. The largest bear on each side about ten lamellæ, the smallest two or three. The whole appearance of the branchial apparatus is quite unlike what is usual in the circum-anal plumes of nudibranchs and recalls the prosobranch gill. The foot is a narrow groove, but has a thin expanded margin, including which the breadth is 6 mm. in large specimens. The anterior margin of the foot is grooved and united with the corners of the mouth, where it is joined by a second ridge, which runs above it and apparently represents the tentacles. The tail is bifid.

The radula has a wide bare rhachis, and the formula varies from about $11 \times 10 + 2.0.2 + 10$ to $15 \times 14 + 2.0.2 + 14$. The innermost tooth is irregular in shape, but consists of a basal portion from one end of which rises a more or less bent spine, while another spine is more or less completely developed at the other end. The second tooth is larger and is more distinctly bicuspid. The other teeth are unicuspid, awl-like, and hardly bent; and those nearer the rhachis are rather stout, but they become slender towards the end of the row. All the different forms of teeth are well represented in Bergh's plates. In the nervous system the ganglia are very distinct. The liver is large, black, and very soft. On its anterior portion, and less detached from it than usual in the genus (*e. g.*, than in *T. coccinea* described above), are two yellowish hermaphrodite glands of a somewhat irregular shape. Indeed, though separable from the liver, they cannot be said to be separate from it. This may be possibly due to the fact that the specimens are in good condition, so that the membranes connecting the

* The gills as represented in the Plate are not sufficiently numerous.

various organs are fresh and strong, whereas in other cases they may have dried up or decayed. The verge is armed with numerous small spines of very variable shape, simple, bifid and trifid. From the genital mass to the tail extends on each side a long, ramified, almost arborescent gland, distinctly visible through the transparent body-wall with which it is united.

TREVELYANA BICOLOR (?). (Plate IV. figs. 1 a-l c.)

[A. & H., Notes on a Coll. of Nud. Moll. made in India, p. 132, pl. xxix. figs. 11, 12.]

The single specimen, which was captured at Prison Island, Zanzibar, was 20 millimetres long, with a very long narrow foot, tapering to a point posteriorly. The whole animal was white, with projecting spots of bright yellow. The tips of the rhinophores and edges of the gills were also bright yellow. The liver showed through the dorsal integuments as a black mass before and behind the branchiæ, and in front of it were seen the yellow reproductive organs. The branchiæ were simple and leaf-like and shrunk together when touched.

The preserved specimen is contracted into a spherical shape, showing no trace of the raised spots or of a mantle-margin. The head-parts are much retracted and distorted, but the anterior margin of the foot seems to have been deeply grooved. The colour is white, but the black liver is still conspicuous. The twelve branchiæ are set in a complete circle.

The radula consists of 26 rows, the widest of which contain 24 closely packed teeth. The first lateral is large and hamate and the next much like it. The other teeth are rather stout, of the bradawl shape or slightly curved. In the pharynx were found the remains of a small tectibranch, which, to judge from its radula and stomach-plates, was probably *Atys*.

I think this form is probably A. & H.'s *T. bicolor*. Their description was made from the drawing which they reproduce and they saw no specimen. The bicoloration there depicted was probably due to the liver being seen through the integuments, for though the picture certainly suggests a black patch on the skin, it will be seen that this patch occupies exactly the position of the liver, and that it bears yellow spots like the white part. It is also possible that Rüppell and Leuckart's *T. impudica* is identical with this form. They describe it (Neue wirbellose Thiere des rothen Meers, p. 33) "corpore dilute lacteo; tentaculis superioribus, maculis ocellisque dorsalibus, branchiis pedisque limbo aurantiacis; dorso tuberculato; branchiis 12 medium dorsi versus sitis; pallio indistincto."

NEMBROTHA B.

[Bergh, S. R. xi. p. 450, figs., xvii. p. 980, figs.; id. Beitr. zu einer Monographie der Polyceraden, ii. p. 658, figs., and iii. pp. 164-5.]

This genus is allied to *Trevelyana*, but both internally and externally can be readily distinguished from it. The coloration is

generally rather sombre but gorgeous, a prevalent tint being very dark green or blue with brilliant lighter markings. The gills are few (3-5), but large and strong. The hermaphrodite gland is as usual, and not collected into globules. A very narrow labial armature is present in some species, but usually there is none. The radula is never very wide and sometimes is very narrow, consisting of a median plate with from three to twelve laterals, of which the first is large and hamate and the rest plate-like. The species are not all equally well known, all our information as to *N. morosa* and *cristata* coming hitherto from drawings by Semper. It would appear, however, that some of my specimens should be referred to the latter species. *N. nigerrima*, *kubaryana*, and *cristata* have a fairly broad radula, with about twelve laterals, and are distinguished by their dark coloration. They are evidently closely related, and may prove to be merely varieties, including *N. morosa*. *N. gracilis*, *diaphana*, *gratiosa*, and *affinis* are lighter in colour, and have a narrow radula with only three or four laterals.

Nembrotha is recorded from the Indo-Pacific and West Coast of Mexico. It is fairly common on the East Coast of Africa.

NEMBROTHA CRISTATA B. [?= *N. nigerrima*, var.] (Plate IV. fig. 2.)

[Bergh, S. R. xi. p. 458, pl. xxxiii. fig. 6.]

Three specimens from the East Coast of Zanzibar. The living animals are described as having a sloping back, long tail, and narrow foot, somewhat like *Ceratosoma*. The texture was soft, and the colour a very dark but brilliant green with black spots, and also narrow stripes of brighter and lighter green. The gills were counted as five, and the rhinophore-pockets were raised.

The measurements of the largest alcoholic specimen are: length 54 millimetres, breadth 15, height of body 13, height of branchiæ above body 8. The texture has become hard and wrinkled, the animals having evidently been strongly contracted. The main stem of the gills is very thick, strong, and muscular, so that it almost forms a valve to protect the pinnæ as in *Notodoris*. The anterior plume is distinct and separate, but the lateral pairs are almost confluent, and it is consequently hard to say where one begins and the other ends, or whether the total number of branchiæ should be reckoned as three, four, or five. The rhinophores are not very large and are completely retracted within smooth projecting sheaths about 2.5 mm. high. The foot is narrow. The relations of the external mouth-parts are much obscured and distorted by the strong contraction which has affected the whole anterior portion of the body, but it appears probable that the foot is grooved and notched with the upper lamina attached to the corners of the mouth, and that the tentacles are horizontal ridges. There is a very narrow labial armature, about half a millimetre wide and hardly visible to the naked eye. It appears to form a complete ring, and is composed

of a loose mass of long, yellow, transparent rods, irregular in shape and often bent.

In the two specimens dissected, the radula consists of 30 and 31 rows respectively, and the formula of each row is, as a rule, $10+1.1.1+10$ or more rarely $11+1.1.1+11$. The median tooth is squarish, not very broad, and bears, as a rule, five denticles on the anterior edge, but sometimes only four, while in one specimen there were only three denticles in the hinder rows. The first lateral tooth is large and sickle-shaped. The corner of the basal part projects over the rhachidian tooth and creates a false impression that it is an accessory denticle. The remaining teeth are generally ten, but sometimes an additional rudimentary one at the end of the row raises the number to eleven. They are little more than flat squarish plates, decreasing in size outwards. Only the first of them shows some traces of a hamate shape.

All the internal organs are of a deep black colour, which rendered their examination difficult. The blood-gland is large. I was not able to make any satisfactory preparations of the reproductive organs, but the glans seemed to be armed with a dense mass of curved rods.

I think this form must be identified with *N. cristata* B., of which, however, no specimen has been described, all that is known of it being Semper's drawing and apparently a few notes. But it is also not improbable that it is a variety of *N. nigerrima* B., from which it differs externally in little except the absence of any red coloration. The number of branchiæ is, as explained, uncertain, but the arrangement shown in Bergh's plate of *N. nigerrima* is certainly not that of these specimens. On the other hand, the presence of the narrow labial armature is an argument for identity.

NEMBROTHA CÆRULEA, sp. n.

Four specimens from Sii Island, near Vanga. No notes on the living animal, except that it was blue and had apparently no red or green mottlings.

The colour of the freshly-preserved specimens was a fine bright indigo, varying in intensity in different parts. One of the specimens was much lighter than the others and also smaller. The whole of its body and the lighter parts of the other individuals were marked with deep indigo spots.

The largest preserved specimen is 43.5 millimetres long, 18 high, and 12.5 broad. The space from the head to the branchiæ is 12 mm. and from the branchiæ to the end of the tail 22 mm., but the tail is longer in this specimen than in the others. The shape is somewhat like that of *Ceratosoma* without lobes, as the back rises considerably from the head to the branchiæ. The integuments are leathery and not at all transparent. The surface is quite smooth, and there is no indication of a mantle-edge. The rim of the rhinophore-pockets is only slightly raised. The rhinophores themselves are large, entirely retracted, with 25-30 deep

perfoliations. As in the last species, the gills are very thick, strong, and muscular, apparently five, but in this case, too, the lateral pairs sometimes coalesce, so that the whole number may be counted as three or four. They are bipinnate. The oral tentacles appear as large, distinct tubercles on each side of the mouth, and were doubtless fairly long in life. The foot is rather broad, with a shallow groove in front; the upper lamina is connected with the sides of the mouth under the tentacles.

The internal organs are mostly of a greyish yellow, not deep black as in the last species. Though the labial cuticle contained a few scattered yellowish rods, no connected armature is visible. The radula much resembles that of *N. cristata*, and has for formula about $27 \times 10 + 1.1.1 + 10$ or occasionally $11 + 1.1.1 + 11$, but the median plate is broader, with five distinct denticulations which do not vary in number. The first lateral has a groove near the end of the hook, and the next two or three teeth have a rudimentary hamate shape. The liver is large. The upper wall of the pericardium is very thick and strong. The verge resembles the figures in Bergh's plates of *Nembrotha nigerrima*, the glans being armed with a profuse mass of hamate teeth. Those on the top seemed rather larger and more curved than in his figures.

This species is closely allied to *N. nigerrima*, but appears to be sufficiently distinguished by (a) its coloration, (b) the only slightly projecting edges of the rhinophore-pockets, (c) the absence of a labial armature, (d) slight differences in the radula, (e) another form of tentacles.

NEMBROTHA AFFINIS, sp. n. (Plate IV. figs. 3 a-3 d.)

[Cf. *N. gratiosa* Bergh, Nudibr. of 'Blake' Expedition, pp. 172-175.]

One specimen caught in a trawl in Chuaka Bay on the East Coast of Zanzibar. Very long and narrow, being 5 centimetres in length and 1 in height.

The living animal was extremely soft, dull violet-black in colour, with dull yellow stripes on the sides and somewhat brighter ones of the same colour on the back. The stems and bases of the gills were light green, and the same colour occurred between the rhinophores and round the edges of their pockets. The pinnæ of the gills looked black, but when seen by transmitted light were of a fine purple. The foot was very narrow, and the animal could not adhere strongly to anything.

The alcoholic specimen is flabby, 28 millimetres long, 5 broad, and 10 high. As the result of this reduction in size, the yellow parts look wider and the black parts narrower, so that the animal appears to be yellow with black stripes, rather than black with yellow stripes as in Mr. Crossland's figure. No doubt, however, the latter is correct; it represents four lateral yellow stripes and one medio-dorsal. The stripes are interrupted in places, particularly on the tail, and there are some long yellow spots between them. The branchiæ are distinctly only three in number, smaller

than usual in the other species, but with a very thick rhachis and bipinnate. The rhinophores are large and exserted, each bearing about 35 perfoliations. The rims of the pockets are very slightly raised. The oral tentacles are two hard black ridges, curved downwards and sideways. The foot is narrow and grooved in front.

The buccal mass was extracted, but the animal was not further dissected in order to preserve the specimen. There is no labial armature. The formula of the radula is $13 \times 3 + 1.1.1 + 3$. The teeth closely resemble those of *N. gratiosa*, the chief difference being that the anterior margin of the wide median tooth (fig. 3 c) is indistinctly bilobed, the right half being always a little higher than the left. The first lateral (fig. 3 d) is large, rather irregular in shape, and with a double hook at the apex.

This form is closely allied to *N. gratiosa*, and were the latter found in the Indo-Pacific region, I should be inclined to regard them as varieties of one species. But *N. gratiosa* is recorded from the West Coast of Mexico*, which lies outside of the Indo-Pacific area; and it is therefore probable that the differences presented by the present animal are real and greater in living individuals. (a) It is not mentioned that *N. gratiosa* is remarkably soft. (b) The present specimen shows no traces of ridges near the rhinophores or on the tail. (c) The coloration of *N. gratiosa* is not dissimilar, but the pattern is spotted whereas here it is striped. (d) The tentacles do not look as if they had ever been ear-shaped. (e) The anterior margin of the median tooth is indistinctly bilobed.

MARIONIA.

[See especially Bergh, in Semper's Reisen, xv. p. 737, & xvii. p. 890.]

All the Tritoniadæ which I have collected in East Africa belong to this genus, unless the form described as *Marionia* sp. is regarded as sufficiently certain to constitute a new generic type. *Marionia* is distinguished from its near allies *Tritonia* and *Candiella* by the presence of a circle of horny plates or leaves in the stomach. The velum bears distinct processes, which are often ramified. The edge of the jaw has one or more rows of denticles, and the radula is moderately wide. The central tooth is broad and more or less distinctly tricuspid. The laterals are hamate, but the first one is larger and clumsier than the others. Provisionally I think it best to divide the forms here described among six species, but am by no means certain that they will all prove valid. When more material can be examined it will probably be found that the species of *Marionia* exhibit many varieties in form and colour and run one into another. It is also not impossible that the denticu-

* In Bergh's 'System der Nudibr. Gasteropoden,' p. 1145, the locality is given as "mare indicum, Amboina," but this appears to be a slip. The animal is described by Bergh among the molluscs of Amboina, but is expressly said to come from Mexico.

lation of the jaw varies with age. Of the six species, *M. pellucida* seems distinct from the others, which are all nearly related to *M. arborescens*. *M. levis* is distinguished by being quite smooth and not at all tuberculate. *M. ramosa* is closely allied to *M. arborescens*, and differs chiefly in having unusually large branchiæ and appendages. *M. viridescens* and *albo-tuberculata* differ from these last two forms in having branched processes on the velum, and are closely allied one to another in structure, though by no means similar in external appearance.

It is noticeable that in none of these forms is the interior of the buccal cavity black, and that most of them have only one fully-developed row of denticles on the jaw.

MARIONIA PELLUCIDA, sp. n.

One specimen dredged in 10 fathoms near Wasin, East Africa.

The living animal showed very little colour but for the pink liver which shone through the transparent integuments. The back was sparsely reticulated with vermilion, turning to deep crimson near the bases of the branchiæ, and also bore some opaque white raised spots. The sides of the body were white and the edge of the velum sandy-coloured. The velum was not bifid, and bore 12 processes, of which 8 were 3-branched. The branchiæ were 13, of moderate size, directed backwards. The finer branches very delicate and transparent.

The alcoholic specimen is yellow, with small tubercles of a lighter colour on the back and sides. It is 15 millimetres long, 5 broad at most, and 4 high. The 13 branchiæ are rather far apart from each other; none are large, and the first pair as well as the last three are minute. The dorsal margin is not very prominent. The rhinophores are large. The velum as described above, but though the outermost processes probably represent the tentacles, they do not seem to be grooved as usual. The long narrow jaws bear three or four rows of denticles on the edge. The radula is at most $22 + 1.1.1 + 22 \times 25$, but many of the rows are much shorter. The central tooth is not very wide and tricuspid, the side cusps being as high as that in the middle. The stomach has a circular band of about 70 small yellowish plates, all of much the same size and usual triangular shape.

MARIONIA LEVIS, sp. n. (Plate IV. fig. 4.)

Six specimens from Chuaka, East Coast of Zanzibar, and Wasin, East Africa. Two were dissected.

The living animals were high and narrow in shape, with a flat back. The sides were described as white, mottled with translucent patches. The ground-colour of the back was a light purplish brown, with stripes of the same colour but darker and others of white. The branchiæ and rhinophores were pink with dark red blotches.

An uninjured alcoholic specimen is 26 millimetres long, 10 high,

and 7 broad in the widest part, but one which was dissected was about twice as large. The colour has become pale green, with a white reticulation on the sides and white stripes on the back. The skin is quite smooth, and there are no tubercles whatever. There are nine or ten pairs of branchiæ, of which the last three are quite small. The rhinophores have long raised sheaths with simple edges; the club is surrounded by six bipinnate plumes. The velum bears at each end a small grooved tentacle of the usual shape and six processes. The two in the middle are simple and smaller; the other four are larger and branched.

The jaws are white and membranous in the smaller and probably immature specimen, yellow and corneous in the larger one. In both there are from 20–30 very large blunt denticles, and also undulations near the edge of the jaw, which in the larger specimen sometimes develop into denticles, so that in about half the length there are two rows of denticles and here and there three. The radula consists in one specimen of 47 and in the other of 45 rows, with a formula of about $80 + 1.1.1 + 80$, which rises to as much as 85 marginals in one and 100 in the other for a few rows. The central tooth is broad and tricuspid; the median cusp is taller than the others, but not very pointed; all the cusps are rather irregular in shape, and have indentations here and there on the edges. The first lateral tooth is large, blunt, and very different from the rest in appearance. The others are hamate. The stomach has a girdle of about 150 horny, yellow, triangular plates of different sizes.

I do not think that this species can be identified with any of the forms the descriptions of which I have seen*. The coloration somewhat resembles *Tritonia rubra* Leuckart and *Tr. hawaiiensis* Pease, but the other details do not coincide. The species differs from the others hitherto found in East Africa in being quite smooth and having no tubercles.

MARIONIA ARBORESCENS B.

[Bergh, in Semper's Reisen, xvii. pp. 890–894.]

One specimen from near Wasin.

The notes on the living animal suggest that it is the same species as *M. ramosa*, and say that it differs chiefly in that the branchiæ, rhinophores, and processes of the velum are much smaller. The colour appears to have been the same as in that species (*i. e.* cocoa and green), and it is noted that there was a greenish tinge in the branchiæ. The back was warty.

The alcoholic specimen does not look much like *M. ramosa*. It is rather bent, but the length appears to be about 21·5 millimetres, the breadth 11·5, and the height 9. The back and sides are covered with flat low tubercles and the epidermis comes off in flakes. The dorsal margin is unusually prominent and projects 3·2 mm. It

* In this group as in others I have not access to the descriptions of a few forms by the older writers, *e. g.* *Tr. palmeri*.

bears eleven pairs of branchiæ, the main axis of which is bifid and the secondary axis bifid again. The first pair of branchiæ are set at the side of the rhinophores, which appear not to be on the dorsal margin, but this arrangement may be due to the contraction of the anterior part of the animal. The velum bears eleven simple processes of irregular length; the outermost are tentacular and grooved as usual.

The jaws bear a single row of very large, bent, almost hamate denticles with slight indications of a second row. The radula consists of 36 rows, with a maximum formula of $27 + 1.1.1 + 27$, but in most rows it is only about $15 + 1.1.1 + 15$. The central tooth is broad, and, as in *M. ramosa*, seems to bear five cusps. The stomach is provided with the usual girdle of about 100 triangular plates, all of much the same size.

This form appears referable with tolerable certainty to *M. arborescens* B.

MARIONIA RAMOSA, sp. n.

One specimen dredged in 5 fathoms, north of Kokotoni, Zanzibar.

The notes on the living animal are as follows:—"Colour cocoa-like. Two rows of big branched processes which are greenish in their finer divisions. The rhinophores and processes of the velum very long. The neck part is long and the whole creature has the shape of *Limax*. Length about $2\frac{1}{2}$ inches."

The preserved specimen is of a uniform light yellowish green, much bent, but about 27 millimetres long if stretched out. The back is only 8 mm. across, but the whole animal looks much broader on account of the large branchiæ. These are thirteen in number, set on the somewhat projecting dorsal margin. The first are a little behind the rhinophores and the last at the end of the tail. None are rudimentary, and the longest are 11 mm. long and almost ribbon-like. The largest tufts consist of three main stems, each of which is trifid again. The velum is ample and bears, in addition to two tentacles of the usual grooved shape, twelve simple digitate processes. The largest are 2 mm. long; the four in the centre are much smaller than the others. The sides and back are tuberculate. The rhinophore sheaths are 5.5 mm. high, with simple but ample and spreading margins. The club is surrounded by five plumes, once or twice pinnate.

The jaws are not very strong, and, except that the cutting-edge is yellow, colourless. Both bear about thirty large pyramidal denticles, at the base of each of which is a small accessory denticle. In parts there are traces of a second line, which might be regarded as mere ridges on the first line of denticles, but which in seven or eight cases seem to be independent formations. The transparent radula consists of 45 rows, containing at most 29 laterals, so that the formula is $45 \times 29 + 1.1.1 + 29$ as a maximum. The central tooth is much as in Bergh's plates of *Marionia arborescens* (S. R. Heft xvii. pl. lxxxviii. fig. 34), and, as

there, looks as if there were five cusps, but the median cusp is in this specimen thinner and more pointed than in the plates. The liver is large and yellowish. Embedded in the front part of it is the stomach, consisting internally of a large, soft, laminated portion, and a ring of about 120 yellowish, fairly stiff, horny plates. They are not all of the same size, the largest being 2 millimetres long and 1 high, and the smallest about half as large.

This species will perhaps prove to be only a variety of *M. arborescens*, from which it is distinguished chiefly by its long ribbon-like branchiæ, which give it a remarkable appearance. The jaws also present some differences.

MARIONIA ALBO-TUBERCULATA, sp. n.

One specimen from the neighbourhood of Wasin, East Africa. Dredged.

According to the notes on the living animal the sides were opaque white, with a reticulate pattern of red-brown. At the centre of each mesh was a small white projection. The back, which was dark brown at the sides and greyish in the centre, bore a similar arrangement of reticulations and projecting spots. The sheaths of the rhinophores were tall, and the wavy edges were turned over outwards. The branchiæ were much subdivided, and very large when fully extended. The main stems were of a light greenish grey, and the finer branches of a dark yellowish brown. The velum was plate-like, with five processes on each side, three of which were branched.

The alcoholic specimen is 45 millimetres long, 15 high, and 13 broad. It does not taper to a point behind. The colour is dirty yellow with profuse white markings. The stems of the branchiæ are spotted and striped with white. There are nine pairs of branchiæ of which the fourth is the largest, but the left-hand plume of this pair is much larger than the other. The middle and left-hand side of the velum are injured. There remain on the right-hand side, starting from the inside, (*a*) a bifid process, with three branches on each bifurcation, (*b*) a simply quadrifid process, (*c*) a simply bifid process, (*d*) a quite simple process, (*e*) a tentacle grooved below. Taking into consideration the notes on the living animal, it appears that there was a similar arrangement on the left side and that the middle of the velum was smooth. There is a small oval papilla below the fourth branchia, close to the dorsal margin. The genital papilla is lower down between the second and third branchiæ.

The jaws are yellow, horny, and large, being 9 millimetres long and 4 wide. They bear a single row of strong denticles, 10 of which are very much larger than the rest. Under five of the largest are indications of a second row. The radula is yellow, and consists of forty rows with a maximum formula of $95 + 1.1.1 + 95$. The central tooth is fairly broad and bears three cusps, of which that in the middle is pointed and those at the sides blunt. The

first lateral is large and clumsy: the rest are of the ordinary hamate shape. The internal organs are whitish. From the large buccal mass issues a tube 14 mm. long and nearly 5 mm. wide. The interior is lined with folds, and there is a pouch-like diverticulum in the floor immediately after the buccal mass. The tube is of much the same size until it dilates into the small stomach (7.5 mm. \times 5.5 mm.), which is under and partly within the liver. The stomach has a girdle of more than 100 plates, very thin and membranous, and all of about the same size, namely, 3 mm. along the base and 1.5 high. They lie in groups so as to produce a superficial impression of about 12 thick plates. The intestine is large.

MARIONIA VIRIDESCENS, sp. n.

[? = *Tritonia hawaiiensis* Pease.]

One specimen from near Wasin.

The notes on the living animal are as follows:—"Sides of foot light greenish brown, netted with light bright green, which becomes white near the edge of the back. There is a broad line of opaque white and green (a mixture resembling verdigris), which sends out prolongations to the bases of the branchiæ. Apart from this line the colour is reddish brown with a greenish network and white spots. This coloration extends into the main stems of the branchiæ, but the finer ramifications are white and the finest of all bright pinkish brown. The whole coloration is strikingly beautiful. The velum bears seven processes on each side; only the largest are branched. The rhinophores project but little from their pockets, which are as in *M. albo-tuberculata*. The branchiæ are kept moving continually, expanding and contracting. The animal is about 4 inches long."

The preserved specimen is 42 millimetres long, 21 broad, and 14 high. The shape is not tapering. The back and the sides bear small flat tubercles. The velum is large; besides the two small grooved tentacles it bears on each side seven processes, the largest of which have 2-4 short branches. The central space is wide and bears four rather indistinct tubercles not amounting to processes. The rhinophores are entirely retracted, and the club is surrounded by six bipinnate plumes. There are ten pairs of branchiæ, of which the fourth is the largest; they still bear traces of green colour. The stout and strong main stem divides into four branches, each of which bifurcates, and each bifurcation is then 3-4-pinnate. The arrangement of the smaller tufts is simpler, but none are rudimentary. The foot is very narrow, being, as preserved, only 2.5 mm. wide. The mouth is large and open, showing the jaws. It is surrounded by a circular disk with thin free margins. All this portion of the specimen seems to have been somewhat distorted by the preserving fluid.

The jaws are 9 mm. long and bear a single row of coarse denticles, of which ten are very large, the rest gradually decreasing

in size. There are only very faint traces of a second row. The radula consists of 37 rows, with a maximum formula of about $90+1.1.1+90$. The teeth are of the shape usual in the genus. The central tooth is finely striated, moderately wide and tricuspid, the central cusp being pointed, those at the sides blunt. From the buccal mass issues a long broad tube (4.5 mm. wide), which passes above and to the left of the genital organs, and then enters the liver, where it dilates into a stomach bearing a girdle of plates. These are about 120 in number, horny, fairly strong, brown, triangular, and of various sizes, the largest being 4 mm. long and 1.5 high, the smallest only a quarter of the size and white. The liver is large, yellowish externally, blackish internally.

In coloration this animal resembles *M. chloanthes* B., but can hardly be identified with that species on account of the differences in the velum, jaws, central tooth of the radula, and stomach-plates. I think it is very probably identical with Pease's *Tritonia hawaiiensis* from the Sandwich Islands, but his description is not sufficiently detailed to make identification certain, and the expressions "Veil strongly digitate," "Tentacles [*i. e.* rhinophores] retractile into . . . lacinated sheaths," hardly apply to the present specimen.

M. virescens and *M. albo-tuberculata* are closely allied and possibly only varieties of one species; but the present specimens exhibit some differences in the velum, median tooth, and digestive organs, as well as in coloration.

MARIONIA, species.

One small specimen, dredged in 10 fathoms off Wasin.

It was dead when found and of a uniform opaque white. The velum was hardly digitate, but presented six undulations. The foot was broad.

The alcoholic specimen has become deep brown and is somewhat decomposed. It is 5 millimetres long, 2 broad, and 1.5 high. The back is tuberculate, with a slightly projecting margin, which bears on each side 6 small branchiæ set at a considerable distance from one another. The rhinophore-pockets are raised and simple. The velum appears simply circular.

No jaws could be discerned. The radula was extremely small, and on a superficial examination appeared to be uniseriate, but on careful investigation was found to have the formula 5.1.5. The laterals are all alike, thin and hamate. They are folded over the central tooth, a narrow plate with slight indications of being tricuspid. The stomach contained about 80 yellow plates, all of much the same size.

This is perhaps an immature form in which the jaws are membranous; but, if so, it is remarkable that the stomach-plates are fully developed. The extreme narrowness of the radula is also remarkable. The characters as described above are sufficient to constitute a new genus, but I hesitate to do this on the evidence of one minute specimen.

BORNELLA.

The members of this genus are slender, elegant animals, having on either side of the back a row of cerata mostly divided into 2-4 branches and bearing gills. On either side of the mouth is a compound tentacular process consisting of a number of conical tubercles set in a sort of rosette. Over the head are a pair of large organs called in the following descriptions for brevity's sake rhinophore-sheaths, but apparently formed by a fusion of the true rhinophore-sheaths with a pair of cerata. The pair of cerata after these organs are called the first pair. The vent is latero-dorsal between the first and second pair of cerata. The buccal mass is not large, but very muscular; besides the jaws and radula, there is also a labial armature of scales. The radula consists of a median tooth, roughly triangular, either smooth or denticulate, and a few (9-19) smooth hamate laterals, bent somewhat forward. The innermost are generally very small, and the size increases towards the outside of the row. There are two stomachs, of which the second is armed with spines, and two accessory livers, besides the main mass. As a rule ramifications of the liver enter the cerata, but there is some irregularity in this respect. The hermaphrodite gland lies on the liver; the præputium is smooth or armed with spines.

There is considerable difficulty in dividing the genus into species. The colour presents little variety, being in all the known forms whitish yellow, with a red or yellow reticulation on the back. On the other hand, there is some variety in both the external and internal organs. The number of the cerata and their subdivisions appears not to be specifically characteristic, but to increase with age, and is not always the same on the two sides of the body. The ramification of the liver may be present or absent in the same species (*B. excepta*; see Bergh's two descriptions), and, when present, may not extend to all the cerata. The armature of hooks on the præputium may also be present or absent in the same species (*B. digitata* and *B. arborescens*; see Bergh). Nine species are recorded, but *B. hermanni* Angas, *caledonica* Crosse, *adamsii* Gr., *semperi* Crosse, and *hancockana* Kel., will hardly prove valid, for even if they represent specifically distinct forms they are insufficiently characterised. Of the remaining species *B. calcarata* Mörch, from the West Indies, is distinguished by having appendiculate rhinophore-sheaths and smooth median teeth. The Indo-Pacific forms fall into two groups—the one represented by *B. digitata*, with a single process behind the rhinophores, cerata divided into rather long erect fingers, and median teeth with faint denticulations; the other by *B. excepta*, with several processes behind the rhinophores, small fingers on the cerata protecting the external branchiæ, and much more distinctly denticulate median teeth. Whether *B. digitata* and *B. arborescens* are really distinct is discussed below. *B. simplex*, n. sp., is certainly a separate species, unless it is a monstrosity.

My specimens seem to be on the whole smaller than those of Bergh and to have fewer cerata.

BORNELLA DIGITATA Adams. (Plate IV. fig. 5 a.)

[A. & H., Notes on a Coll. of Nud. made in India, p. 140, pl. xxxiii. figs. 8, 9; Bergh, S. R. vii. p. 301; id. Danish Exp. to Siam, Opisthobranchiata, p. 199.]

Several specimens from Zanzibar Harbour (Bawi and Prison Island).

The living animals were white, with a granulated surface. On the back was a reticulate pattern of deep orange. The cerata were tipped with opaque white, below which was a band of bright orange. The transparency of the body-walls varied in different specimens. In some the liver and its ramifications were clearly visible.

The following description, when not otherwise stated, applies to the largest alcoholic specimen; the others are much like it, but the smaller ones are only half the size. Length 30 millimetres, breadth 4, height 8.5; much compressed laterally. On each side of the mouth is a large branched process with about fifteen subdivisions; of these the four or five uppermost are larger and digitate; the remainder are round and tubercular. The back bears a pair of rhinophores with appendages, and, as a rule, four pairs of cerata behind them. The largest specimens have a fifth pair of small cerata, which in one case are fused together into a single process. The rhinophore-sheaths are raised; they bear in front three small digitate processes, and behind one long tapering process which rises 5.5 mm. above the rhinophores. The first pair of cerata are divided into two large and two small fingers; the right-hand member of the second pair into two approximately equal fingers, and the left into two large and one small; the third into one large and one small finger; the fourth are simple; the fifth are merely small warts. In the smaller specimens the first pair of cerata are trifid only, and in the smallest bifid, with indications of an incipient third digit. It appears probable that the number of digits increases with size and age. The first pair of cerata bear three branchiæ, the second, third and fourth two, the fifth none. The branchiæ are all on the inner side of the cerata and set close together.

The labial armature consists of small overlapping scales, arranged in fairly regular rows. The edge of the jaws is quite smooth. The radula consists of 34 rows. The median tooth has a long central cusp, with from 8 to 10 denticulations or ridges at the base. In most rows there are 9 laterals, increasing in size from the innermost outwards, but in some the number rises to 13 and 15. The walls of the second stomach are raised into folds on which are set large brown thorns, with rather blunt tips. The ramification of the liver appears to be very irregular and to vary in different specimens. In the largest the arrangement is as follows:—A single branch runs up into the tall tapering process behind each

rhinophore; the first pair of cerata receive no branches at all; the second and third receive on the right hand a branch which bifurcates, and on the left a simple branch which, in the third, stops at the base of the cera and does not enter it. The remaining cerata receive no branches.

I think these specimens are the *B. digitata* described by A. & H. and by Bergh. The best external character seems to be the tapering, finger-like shape of the cerata and of the process behind the rhinophores, to which no doubt the specific name is due.

BORNELLA ARBORESCENS Pease.

[Bergh, "Neue Nacktschnecken, No. ii.," Journ. Mus. Godeffroy, Heft vi. 1874, p. 96; id. S. R. xvii. p. 886.]

Several specimens from Mombasa Harbour. Note on living animals: "Yellowish white, with red reticulations on back and red tips to cerata."

The alcoholic specimens are all much of the same size. All are whiter and more compressed than those of *B. digitata*, and the cerata are much smaller. The average dimensions are:—Length 20 millimetres, height 6, breadth 3; rhinophores and cerata about 2 mm. high. The tentacular processes at the side of the mouth consist of only about six digitations. The rhinophores are as in *B. digitata*, but the posterior process is not so long. In most specimens there are five pairs of cerata, of which the first three are bifid and the remaining two simple. Each, from the first to the fourth, bears two gills, the fifth none. The jaws and labial armature are as in *B. digitata*; the formula of the radula is about $40 \times 9.1.9$, rising sometimes to $12.1.12$. The teeth are much as in Bergh's plates (Journ. Mus. Godef. l. c. plate iv. 12), but the central cusp of the median tooth is rather longer. The median tooth is more erect than in *B. digitata*, and the 8–10 denticles which it bears less distinct and very hard to see. The other characters are as in *B. digitata*.

It is not easy to say whether this form is specifically distinct from *B. digitata* or, if so, whether it should be called *B. arborescens*. It represents, however, at least a well-marked variety or stage of growth in which the tentacular processes, rhinophores, and cerata are less amply developed. It could hardly be identified with *B. arborescens* on the strength of the original description by Pease (Amer. Journ. of Conchol. vi. 1871), but in the revised description by Bergh (Mus. Godef. l. c.) the chief specific character seems to be "*papillis anterioribus ut plurimum bipartitis*." In these specimens they are invariably bifid. With regard to the hooks on the præputium, I was unable to see the difference mentioned by Bergh, and found only simple or bifid hooks, not trifid, in both species.

BORNELLA EXCEPTA B. (Plate IV. fig. 5 b.)

[Bergh, Challenger Reports, Nudibranchiata, p. 36; id. Danish Exp. to Siam, Opisthobranchiata, p. 202.]

One specimen from the East Coast of Zanzibar. Notes on living animal: "Rhinophore bearers very large indeed; colour whitish, netted with orange."

The alcoholic specimen is more stoutly built than those already described. It is somewhat bent, and would be at least 30 millimetres long if stretched out. It is 5 mm. high and 4.5 broad. The rhinophore-sheaths are 8 mm. high, the cerata 5.5.

The tentacular process consists of 11 fairly long digits, all distinct and none of them merely tubercles. The large rhinophores bear 7 digits, three in front quite separate, and five behind united at the base. Posteriorly there are traces of what may be a crest. Behind the rhinophore-sheaths are three pairs of cerata, somewhat resembling those of *Doto* in general appearance. They all bear three digits, above which rises the top, covered with knobs. They also all bear three stout branchiæ, two of which are visible from the outer side and are protected by the digits.

The jaws and labial armature are much as usual; the former have blunt indentations on the edge. The radula consists of 27 rows with a maximum formula of 16.1.16. In the median tooth the central cusp is rather longer than depicted by Bergh, and there are 10-12 denticles and ridges on each side. The second stomach and the præputium are armed with black spines as described by Bergh (Chall. Rep. l. c.). The liver sends branches into all the cerata except the right-hand member of the first pair, but not into the rhinophore-sheaths.

I am somewhat doubtful if this is really Bergh's *B. excepta*: there are differences in the arrangement of the cerata and branchiæ and the rhinophore-sheaths are relatively much larger. On the other hand, the two specimens examined by Bergh did not agree in details, and the present animal possesses more or less the characters common to them.

BORNELLA SIMPLEX, sp. n. (Plate IV. fig. 5 c.)

One specimen from Chuaka, East Coast of Zanzibar. The following are the notes on the living animal:—"Very like *B. digitata*, but a distinct species. Anterior tentacles short and simple. Whole coloration transparent, so that the walls of the heart are distinctly visible. No opaque white or orange rings on tips of cerata, but an orange network on the back and a row of opaque white dots on the sides. Eyes not visible. Length 12 millimetres."

Superficially the alcoholic specimen looks much like *B. excepta* as described above and has the same *Doto*-like cerata, but it is at once distinguished by having on each side of the mouth not the usual tentacular rosette, but a single simple tubercle. The left tubercle is larger than the right. The rhinophore-sheaths bear six short digitations and a larger rounded knob behind. There are four pairs of cerata, of which the hindmost are simple warts. The others are similarly constructed, though the third pair are smaller than the first two. Each is divided into four knob-like

divisions, and bears a pair of trifid feathery branchiæ, one anterior and one posterior.

The mouth-parts were taken out soon after the specimen was captured, and as preserved consist of a labial armature and radula, but no jaws. It is very likely, however, that the jaws had been lost and were not really absent. The labial armature is much as in *B. digitata*. Many of the scales are heart-shaped. The formula of the radula is $21 \times 9 + 1 + 9$, the number of laterals being constant in all the rows. The median tooth has 7-8 very strong denticles on each side of the central cusp, which does not project much. The laterals are rather short and straight. The second stomach is armed with spines as in *B. excepta*. The liver sends off diverticula into the process behind the rhinophores and all four pairs of cerata. Those which pass into the rhinophore-sheath and the fourth pair of cerata are simple, while those that pass into the other cerata are divided into four branches corresponding to the divisions of the cerata.

The simple tentacles of this animal are a sufficient specific, if not generic character, provided they are normal. It is possible that they are a monstrosity, for it is not uncommon in nudibranchs for external processes to remain undeveloped, for example, I have a specimen of *Ceratosoma cornigerum* in which the characteristic lobes are wanting. But apart from the tentacles, this specimen does not exactly correspond with *B. excepta*, for instance as regards the rhinophore-sheaths and radula. The median tooth has fewer and stronger denticulations; the laterals are fewer, shorter, and straighter.

PLEUROLEURA ALBA, sp. n.

[Cf. *Pl. striata* van Hass., Eliot in Nudibr. of Maldives and Laccadive Archipelagoes, p. 566-7.]

Two specimens from Zanzibar. The following are the notes on the living animal:—"Back white with distinct low ridges, longitudinal but not parallel to median line, each with a yellow line along its summit. The rhinophores stand vertically or point forwards and bear longitudinal perfoliations. The base is white, the main part black, the apex truncated and yellow. They are not retractile into pockets, but can be withdrawn under the mantle-edge. They are not very sensitive. The large velum and the mantle are edged with bright yellow. Foot not half the width of mantle. In crawling, the underside of the mantle is applied to the substratum over which the animal moves. Length 13 millimetres, breadth 4 mm."

The dimensions and colour of the preserved specimen have not much altered, though the yellow has become faint. The shape is elongate and tapering. The maximum breadth just behind the rhinophores is 4 millimetres, rapidly decreasing to 3 mm. and 2 mm. One striation runs down the middle of the back; on each side of it are six to eight others, not parallel to it and starting

from various points. The external characters are those of the genus.

The mouth-parts on the whole resemble those of *Pl. striata* as described by me (*l. c.*). The formula of the radula is $23 \times 6 + 1.1.1 + 6$. The rhachidian tooth has a long central cusp and about six denticles on each side. The first lateral is practically half the rhachidian tooth, having one tall cusp and about six denticulations parallel to it and rising from the base on the outside. The remaining teeth are simply hamate. The jaws are more membranous than in *Pl. striata*, and bear six distinct rows of denticles.

This form is closely allied to *Pl. striata*, but differs strikingly in colour, that animal being black with yellow lines. Such variation in colour is not impossible within the limits of a species, but in this case it is accompanied by other differences:—(1) The shape is more elongate; (2) the radula is narrower; (3) the first lateral is differently shaped. These points seem sufficient to constitute provisional specific rank, though it is quite possible that the form may ultimately prove a mere variety of *Pl. striata*.

EXPLANATION OF THE PLATES.

PLATE III.

Figs. 1 a-1 g. *Notodoris minor*, p. 84.

1 a. Lateral view of living animal. 1 b. Dorsal view of living animal.

1 c. Hinder part of body with the valves raised and spread. 1 d. Gills with the valves removed. 1 e. Ventral view of anterior part of body.

1 f. Glans penis. 1 g. Three teeth.

2 a-2 f. *Trevelyana coccinea*, p. 85.

2 a-2 d. First laterals of various shapes. Teeth from (2 e) middle and (2 f) end of row.

3 a-3 c. *Trevelyana ceylonica*, p. 86.

3 a. First lateral tooth. 3 b. Teeth from the middle of a row. 3 c. Three teeth, seen from below and behind.

4. *Trevelyana crocea*, p. 87.

PLATE IV.

Figs. 1 a-1 c. *Trevelyana bicolor*, p. 89.

1 a. Lateral view of living animal, with the liver (the blackish tint) showing through the translucent body-wall. 1 b. Ventral view of crawling animal, showing the proportions of the foot and some of the internal organs through translucent body-wall. 1 c. Gills as seen fully expanded. Figs. 1 a and 1 b are $\times 5$.

2. *Nembrotha cristata*, p. 90.

Middle of radula.

3 a-3 d. *Nembrotha affinis*, p. 92.

3 a, dorsal and (3 b) lateral views of living animal. 3 c, median and (3 d) first lateral teeth.

4. *Marionia levis*, p. 94.

5. Median teeth of (5 a) *Bornella digitata* (p. 101), (5 b) *B. excepta* (p. 102), and (5 c) *B. simplex* (p. 103).

2. Description of a new Tree-Frog of the Genus *Hyla*, from British Guiana, carrying eggs on the back. By G. A. BOULENGER, F.R.S., V.P.Z.S.

[Received April 30, 1904.]

(Plate V.)

HYLA EVANSI.

Tongue subcircular, slightly nicked behind, slightly free behind and on the sides. Vomerine teeth in a strong transverse series, narrowly interrupted in the middle, between the very large choanæ. Head as long as broad; snout obtusely pointed, a little longer than the diameter of the orbit; canthus rostralis strong, straight; loreal region very oblique and concave; nostril much nearer the tip of the snout than the eye; interorbital region slightly concave, nearly as broad as the upper eyelid; tympanum very distinct, three-fifths the diameter of the eye. Fingers free; no distinct rudiment of pollex; toes three-fourths webbed, the web reaching the disks of the third and fifth, two last phalanges of fourth free; disks a little smaller than the tympanum; no tarsal fold. Skin finely granulate above, more coarsely on the belly and under the thighs, smooth on the throat. Brown above, speckled and spotted with darker, limbs with regular dark cross-bars; white beneath, throat, breast, and limbs speckled with brown.

From snout to vent 75 millim.

The unique specimen, a female, carries its eggs on the back, fitting into shallow hexagonal impressions in the skin; these eggs, 22 in number, measure 8 or 9 millim. in diameter, and contain tailed larvæ with rudimentary limbs and with allantois-like membranous respiratory organs. In this it agrees with *Hyla goeldii* Blgr.*, to which it is nearly related, and with *Ceratohyla bubalus* Esp.†

This remarkable Frog was obtained at the end of November, 1902, at Groete Creek, Essequibo, by Dr. R. Evans, who has kindly presented it to the British Museum, together with a sketch made from the fresh specimen, and showing the embryos in position; these have unfortunately come off in transit.

EXPLANATION OF PLATE V.

Hyla evansi, sp. nov. Natural size.

* Cf. Boulenger, P. Z. S. 1895, p. 209, pl. x. figs. 1-3.

† Cf. Boulenger, P. Z. S. 1903, ii. p. 115, fig. 8.



3. Notes upon the Anatomy of certain Snakes of the Family *Boidæ*. By FRANK E. BEDDARD, M.A., F.R.S., Professor to the Society.

[Received May 2, 1904.]

(Text-figures 19-23.)

The Boidæ are held by most zoologists to occupy a place near the base of the Ophidian series. This view is based chiefly upon the paired lungs, the considerable rudiments of the hind limbs, and upon some other osteological points which are duly summed up by Boulenger*. The viscera also confirm this opinion; and I propose in the following pages to call attention to some new or little-known facts relating to the circulatory system which collectively support it.

§ *Gubernaculum cordis, and Right and Left Aortæ.*

No member of the genera *Python*, *Boa*, *Eunectes*, and *Eryx* which I have dissected possesses any trace whatsoever of a gubernaculum cordis tying down the apex of the heart to the walls of the pericardium. It is not altogether unnecessary to record the absence of a gubernaculum, though it has been stated that the Lacertilia are to be contrasted with the Ophidia by the presence in the former and the absence in the latter of this gubernaculum. A more correct statement would be arrived at if the word "generally" were interpolated in both cases. I find, in fact, considerable vestiges of this tag in several Ophidia. It occurs for example in *Coronella getula*. In *Cælopeltis monspessulana* a thin sheet of membrane runs from the ventricle some little way above the apex to the vena cava and passes down the latter to the posterior wall of the pericardium.

In the Hamadryad (*Ophiophagus bungarus*) the covering membrane of the heart (= visceral layer of peritoneum) is obvious and can be stripped off. Posteriorly, this membrane forms a tubular prolongation of which one side is attached to the vena cava at its entrance to the heart and to the pericardium beyond, while the other is attached to the pericardium wall behind. The ventricle, therefore, near to the apex, but on one side, is attached not merely to the vena cava, but also to the wall of the pericardium.

It is impossible to speak of these structures but as a gubernaculum cordis. On the other hand, it is clear that they differ somewhat from the gubernaculum in the Lacertilia, which has no relation to the vena cava but attaches the actual apex of the ventricle to the pericardial wall, and is of more ligamentous consistency.

The structure is therefore possibly a new one in the Ophidia, on which view its total absence in the Boidæ (so far as the material which I have examined enables me to say) may well be

* Catalogue of Snakes in the British Museum (Natural History), London, 1893.

a primitive character. There is no *a priori* objection to deriving the Ophidia from some Lacertilian form in which the characteristic lacertilian "tag" to the heart was absent. In the genus *Varanus*, for example, the gubernaculum is absent, as others as well as I myself have observed; and it may be pointed out that the Ophidia might well have been derived from some form in which, as in *Varanus*, the neck was long, the lungs firmly bound down to the dorsal parietes, the trachea or bronchi continued for a considerable distance through the lung, and the urinary bladder absent.

The fact that in *Eryx* the right and left aortic arches are equal in size at their junction to form the unpaired dorsal aorta seems to me to be undoubtedly a primitive feature. I may furthermore observe that this feature is figured * by Dr. Gadow as characteristic of *Pelophilus (Boa) madagascariensis*. Apparently, however, *Python bivittatus* has unequal right and left aortæ †. In other serpents it is common for the right aortic arch to be smaller than the left, and this is carried so far in *Zamenis flagelliformis* as to give the impression that the right aorta is a mere inconspicuous forwardly running branch of the left ‡.

§ Intercostal Arteries.

The intercostal arteries in *Eryx jaculus* show some interesting features, which are partly indicated in the accompanying drawing (text-fig. 19, p. 109). In the anterior region of the body the arteries in question arise from the left aorta immediately after it has parted company with the anterior vertebral. Anteriorly to this point some arise from the left aorta, but that region of the body is supplied from the vertebral artery. The intercostal arteries which arise from the right aorta and from the first part of the conjoined aortæ are single trunks given off at irregular intervals not corresponding to the individual vertebra. They join above, however, to form a continuous and slender dorsal artery which may be termed the posterior vertebral artery (*P.v.*); from this arise at regular intervals the paired intercostals.

After the end of this vertebral artery the aorta continues to give off the dorsal intercostals which, when they reach the median dorsal line, run along it for a short distance anteriorly and posteriorly, giving off as before paired branches to the intervertebral regions. But there is no formation here of a continuous longitudinal trunk running over more than three or four vertebrae. So far the arrangement is precisely such as I have lately described in another Boid, viz. *Python spilotes* §. But whereas in the last

* Bronn's Klassen und Ordnungen des Thier-Reichs, Bd. vi. Abth. iii. pl. cxxxv. fig. 1.

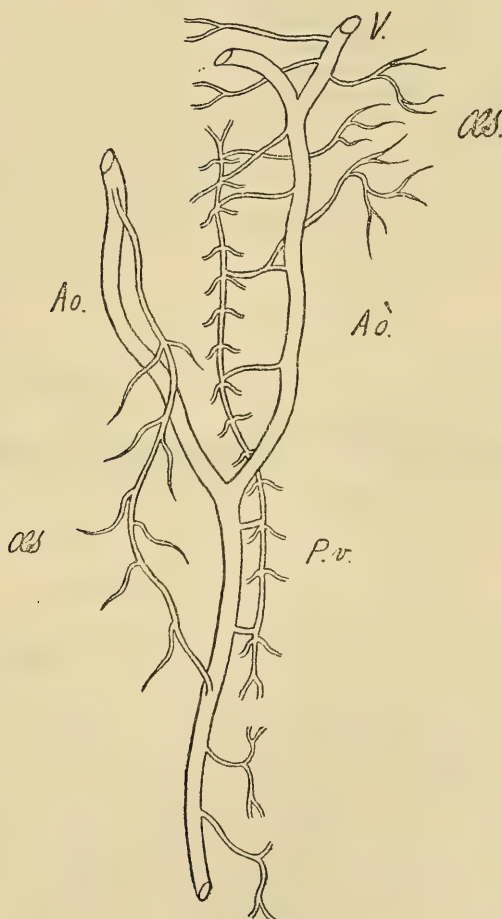
† *Loc. cit.* pl. xxxiv. fig. 2. The figure is copied from Fritsch.

‡ Beddard, "Contributions to our Knowledge of the Vascular System in the Ophidia," P. Z. S. 1904, vol. i. p. 338.

§ "Contributions to our Knowledge of the Circulatory System in the Ophidia," P. Z. S. 1904, vol. i. p. 362.

named snake this arrangement of the intercostals persists to the end of the body, in *Eryx jaculus* another arrangement comes into force further down the body which is displayed in the drawing reproduced as text-fig. 20, p. 110. First of all, *i. e.* anteriorly,

Text-fig. 19.

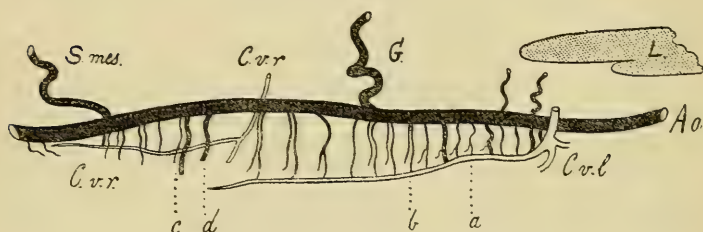
Part of intercostal arterial system of *Eryx jaculus*.

Ao., right, *Ao.*, left aortic arch; *æs.*, oesophageal twigs; *P.v.*, posterior vertebral artery; *V.*, vertebral artery.

the intercostal arteries begin to arise regularly from the aorta, and, when they reach the parietes, do not form short longitudinal vessels which give off paired branches to several successive

vertebræ; but each intercostal bifurcates close to the parietes and supplies but a single intervertebral area. The arrangement in this region of the body in fact is precisely like that figured by Jacquart* for *Python sebae*, and which I can confirm from my own dissections of the same serpent. In *Python sebae*, however, this arrangement appears to persist throughout the whole body. In *Eryx*, on the other hand, a little way back, a third mode of arrangement of the intercostal arteries occurs. The point of bifurcation of the single intercostal advances higher up its stem (*a* in text-fig. 20) until (*b*) a right and left intercostal is established arising separately from the aorta. A further differentiation is shown in the case of the intercostals lettered *c* and *d* in the figure referred to. It will be observed that in *c* the left intercostal is much thicker than its fellow and than most of the neighbouring intercostals, while in *d* the vessel has become single owing to the complete disappearance of its fellow. These facts indicate the way in which the irregular intercostal arteries (sometimes right and

Text-fig. 20.

Part of intercostal arterial system of *Eryx jaculus*.

Ao., aorta; *a*, *b*, *c*, *d*, intercostal arteries; *C.v.r.*, *C.v.l.*, right and left posterior cardinals; *G.*, gastric artery; *L.*, end of liver; *Smes.*, superior mesenteric artery.

sometimes left and at unequal distances) of more modified snakes have been formed. Obliterate in the accompanying drawing (text-fig. 20) the finer intercostals and leave only those of magnified calibre, and the result would be a reproduction of the intercostal system in many Colubrine Snakes. This double series of intercostal vessels in *Eryx* has its counterpart in *Eunectes murinus*. In the Anaconda I find both intercostals arising singly which run for varying distances along the median dorsal line giving off paired branches to the parietes, and regularly paired intercostals arising separately from the dorsal vessel. It is important to notice the agreement in these particulars between *Eryx* and *Eunectes* and the difference from *Python*, since the two former belong to the subfamily *Boinae*, and the latter, naturally, to the subfamily *Pythoninae*. It is difficult to say which of the

* Ann. Sci. Nat. (4) iv. p. 321.

two arrangements of the intercostals, the Boine or the Pythonine, is the more primitive; perhaps it is the former. In any case it is from the Boine rather than the Pythonine type that the intercostal system of many Colubrine Serpents is derivable.

Eryx conicus differs in detail from *Eryx jaculus* in the arrangement of the intercostal arteries. Anteriorly, the arteries are given off singly and regularly, bifurcating just before their entry into the thickness of the parietes. There is with great regularity one to each vertebra. The only exception that I noticed was in the case of one intercostal arising from the right aorta in front of the junction of the two aortæ, and of another some way behind; these supplied two intervertebral spaces. This apparently is the only trace left anteriorly of the arrangement characterising *Eryx jaculus*. Far back, much further than in *E. jaculus*, the paired arrangement of the intercostals is seen. Still it is evident that the two species do not differ in the type of the arrangement of the intercostals.

Eryx johnei again shows a fundamental likeness to, but detailed differences from, the other two species of the genus. The general agreement is that the anterior series of intercostals arise singly from the aorta and bifurcate only just before entering the parietes. They begin to be double in origin shortly behind the liver. In the region where they are double they are frequently asymmetrical in both size and in point of origin from the aorta. Thirteen intercostals arise from the right aortic arch before its union with the left. There is no trace of any formation of an azygos median vertebral artery such as occurs in *Eryx jaculus*. The intercostal system of this species in fact is somewhat intermediate between those of the two other species of the genus.

§ Some Visceral Arteries.

Œsophageal arteries.—I have examined these arteries carefully in an injected example of *Eryx jaculus*. It agrees with other snakes and with the Lacertilia in the fact that the intercostals (already described on p. 109) arise from the right aortic arch only. On the other hand, branches to the œsophagus, which are represented in the drawing (text-fig. 19, p. 109), arise either directly or indirectly from both arches. I have not observed this double origin of the œsophageal branches in any other Ophidian; but, as I am not quite in a position to deny its occurrence, I cannot emphasise the fact as a characteristic of the Boideæ. It is, however, I am inclined to think, an anatomical feature not found in the Lacertilia. The œsophageal vessels, or rather vessel (for I only noticed one), arises from the left aorta; it passes back along the œsophagus, giving off branches to that gut, and becomes continuous with the first of the œsophageal arteries arising from the conjoined aortæ. The right aorta does not directly give off œsophageal arteries. But from two of the intercostals of the right aortic arch such arteries arise.

In *Eryx johnei* the same series of œsophageal branches arising from intercostals are present. They arise from intercostals partly belonging to the right aortic arch, and partly to those arising from the common trunk. The third intercostal, after the union of the two aortæ, gives off a slender vessel which runs forward and joins a vessel arising from the last but four of the intercostals belonging to the right aorta. This longitudinal trunk gives off several lateral vessels. The third, fourth, and fifth of the intercostals of the right aortic arch also give off single œsophageal vessels.

I have pointed out in another paper* that the Lizard *Pygopus* is unusual by reason of the fact that some of the visceral arteries arise from intercostals instead of directly and independently from the aorta. In *Eryx johnei* precisely the same mode of origin occurs not only for œsophageal arteries, but for a fat-body artery. This springs from the right-hand intercostal of the seventh pair after the posterior renal artery.

I observed the exact converse of this state of affairs in *Tropidonotus fasciatus*. The right aorta gives off intercostal branches, but no twigs to the œsophagus that I could find. On the other hand, a single parietal vessel, accompanied closely by a vein, enters the parietes a good way to the left of the middle dorsal line and arises unmistakably from the left aortic arch, which also, of course, gives off several branches to the œsophagus.

Gastric arteries.—The fact that in *Eryx* there are only two† and in *Python spilotes* only three gastric arteries, appears to me to be an archaic point of structure in these Boid snakes. Among the Ophidia generally there is frequently a large number of gastric arteries. For example, in the genus *Coluber* I have found as many as ten or eleven. The reduplication of these and other arteries, so characteristically Ophidian, seems therefore obviously to mark the more specialised members of the group. The absence of, or less, reduplication is not therefore inconsistent with the less modified, more archaic, structure.

Ovarian arteries.—It is at least rare among snakes‡ for the arteries supplying the gonads to arise from the aorta opposite to each other. As a rule one spermatic or ovarian artery follows the other in relation to the asymmetrically placed gonads. Nevertheless in a female *Eryx conicus* the two arteries arose side by side. They immediately follow, as is usual, the superior mesenteric. The paired condition of these arteries seems to me to be a primitive feature in the organisation of this snake.

Renal arteries.—It is the general rule among the Ophidia for each kidney to be supplied with a considerable number of arteries. There are, for example, as many as eight in *Coluber catenifer*. Among such Boideæ as I have examined, the number is invariably one or two arteries only to each kidney. In *Python sebae*, *Eunectes*

* Above, p. 12.

† I could find only one in *Eryx johnei*.

‡ I have not myself observed a single instance in the Ophidia except in the case mentioned above.

murinus, *Eryx johnei*, and *Eryx conicus* each kidney had only one renal artery. In *Eryx jaculus* there was some variation in the two examples studied. In one there were two renal arteries for each kidney; in the other the left kidney had two arteries, the right only one. Here, it may be remarked in passing, is an apparent difference between the two species of *Eryx* investigated by me, which I shall refer to again later.

Now, as the kidneys of *Eryx* are very short* and those of *Coluber catenifer* long, as they are in the majority of snakes, it might be held that the arterial blood-supply had merely a relation to length. That the character is one peculiar to the Boidæ seems to be shown by the case of *Eunectes murinus*, for in this serpent there is only one renal artery to each kidney; and yet those organs, in the individual which I dissected, measured respectively $15\frac{3}{4}$ and $12\frac{1}{2}$ inches in length.

§ Veins of the Posterior Abdominal Region in *Eunectes*.

The caudal vein emerges from the thickness of the parietes some way behind the cloaca. When it reaches the level of the cloaca, two veins, asymmetrically placed with regard to one another, join it. I suppose that these are the equivalents of the ischiadic veins of Lizards. Further forward, between the cloaca and the very anteriorly situated kidneys †, the caudal vein divides at once into three branches. The middle one of these is the right and larger anterior abdominal vein. To the left of this arises the afferent renal vein of the left kidney, and to the right of the anterior abdominal a vein which runs over the viscera to the dorsal surface of the body, where it enters the parietes to the left of the middle line, after running both forwards and backwards for a short distance. I am inclined to regard this vein as the equivalent of the lateral abdominal vein of its side in the Lacertilia. Its place of origin agrees with such an homology, and the shortness of its course within the body-wall is no reason against the comparison, since it is of varying length among the Lacertilia. It might be held that this vein is in reality only the proximal end of the left afferent renal which has lost its connection with the remainder of that vein, were it not for the conditions observable in *Eryx* to which I recur later (see p. 114). There is, in fact, no afferent renal on this side of the body springing from the caudal vein and corresponding in origin to the fully developed afferent renal, whose origin on the other side of the anterior abdominal has been already referred to. It rises, I presume, from the caudal vein further back.

* In *Eryx johnei*, which measured 26 inches from snout to vent, the kidneys were respectively $\frac{3}{4}$ inch (right kidney) and 1 inch (left kidney) in length. In *E. jaculus* of $15\frac{3}{4}$ inch length to vent, the kidneys were proportionately larger, *i. e.* $\frac{7}{8}$ inch and 1 inch, and in *E. conicus* of 27 inches this was also the case; they measured $1\frac{1}{2}$ and $1\frac{1}{4}$ inch.

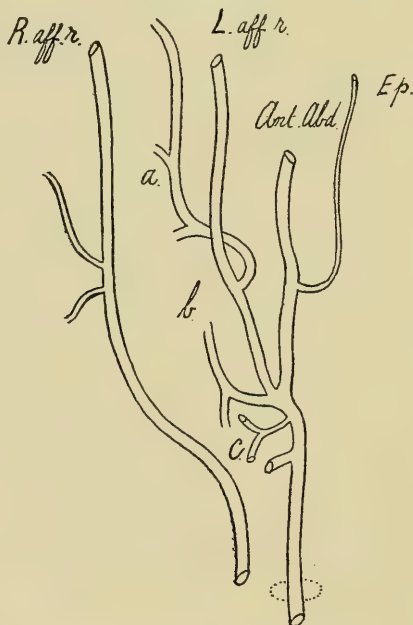
† The kidneys are well known to occupy a very anterior position in the Boïdæ. It has not, I think, been noted that *Eryx* as well as *Eunectes* agrees in this with *Python* and *Boa*.

The *anterior abdominal* vein is double, but the right vein is very considerably larger than the left, especially posteriorly. The two join far forward in the immediate neighbourhood of the pancreas. They are here more nearly equisized. Posteriorly there is another and the only other junction between these paired veins not far in front of the trifurcation of the caudal vein. After this point the left anterior abdominal vein receives a branch from the body-wall and ceases. It is not directly connected, as already mentioned, with the caudal vein. Just after its origin from the caudal vein the anterior abdominal gives rise to the single *median epigastric* vein, which runs forward at least as far as the liver, to which it gives off several branches.

§ *Veins of the Posterior Abdominal Region in Eryx.*

It is remarkable that differences occur in these veins between the two species *Eryx jaculus* and *E. conicus*, if, that is to say,

Text-fig. 21.



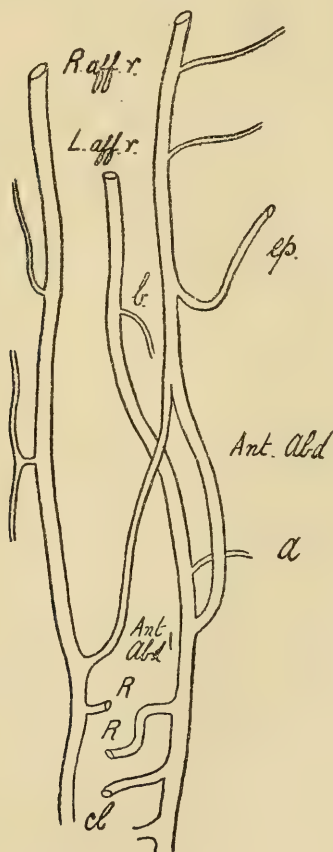
Certain abdominal veins in *Eryx conicus*.

a, b, c, parietal veins; *Ant. Abd.*, anterior abdominal; *Ep.*, epigastric;
L. aff. r., left afferent renal; *R. aff. r.*, right afferent renal.

the single example of *E. jaculus* which I have examined represents the normal state of affairs. The veins in question in *Eryx conicus*

(text-fig. 21, p. 114) are disposed as follows:—The caudal vein gives off first the right afferent renal; after the cloaca (*i. e.* in front of that aperture) it gives off two branches to the dorsal parietes and then divides into three veins as in the Anaconda. Shortly after its origin, the anterior abdominal gives rise to the single epigastric vein. The arrangement of veins in this snake is in

Text-fig. 22.

Certain abdominal veins in *Eryx jaculus*.

R, branches to rectum; *cl.*, branches to cloaca. Other letters as in text-fig. 21.

fact precisely as in *Eunectes*. In *Eryx jaculus*, on the other hand, there are differences which are illustrated in the accompanying figure (text-fig. 22). The caudal vein apparently divides into two—but I am a little uncertain—and each of these vessels

gives off at least one branch to the rectum. A little further forward each vein certainly divides into two branches. These branches are, on each side, a renal afferent and a component of the anterior abdominal vein. Both afferent renals receive, as usual, branches from the dorsal parietes. The two roots of the anterior abdominal vein are unequal in size, that of the right hand being considerably the less. It is important to note this fact, since in *Eryx conicus* the left root of the anterior abdominal vein is the only one which persists. The epigastric vein arises from the anterior abdominal shortly after the junction of its two roots. *Eryx johnei* agrees with *E. jaculus*.

It is a peculiarity of Snakes as contrasted with Lizards, that the anterior abdominal is occasionally partly double, whereas in Lizards it is single after the fusion of its two roots. In the Colubrine and Viperine snakes, so far as my experience goes, the anterior abdominal is usually single except at its extreme posterior end. In *Zamenis gemonensis* the vein bifurcates posteriorly, and after a very short course ends in minute branches in the fat-body. In *Causus rhombeatus* the extent of the bifurcate region of the anterior abdominal is not much greater; for 8 inches intervene between the opening of the anterior abdominal into the portal and its bifurcation posteriorly, which is $2\frac{7}{8}$ inches from the vent. In *Boa constrictor*, on the other hand, there are 23 inches between the vent and the fusion of the two anterior abdominals anteriorly, which point is 10 inches behind the liver, and therefore less from the point of union of anterior abdominal and portal*.

In the Anaconda the double character of the anterior abdominal vein has been already referred to. In one specimen of *Eryx conicus* it was single throughout. In another it was partly double, as was also the case with two individuals of *Eryx jaculus*. In *Python sebae* (where it is figured as partly double by Jacquart †) the fluctuation of this vein between the single and double condition was more plainly seen. Just in front of the gall-bladder the vessel communicates with the gastric portal vein; from this point to two inches behind the gall-bladder it is single. Then for a distance of $4\frac{1}{2}$ inches it is formed of two tubes lying side by side; these reunite, and finally again separate to form two tubes.

In *Eryx johnei* the vein appears to be single after the union of its two posterior roots.

Jacquart figures a somewhat different state of affairs in *Python*. The anterior abdominal bifurcates posteriorly and communicates with only one afferent renal directly as in the Anaconda. The other branch only communicates indirectly (by means of small veins) with the left renal afferent. Hochstetter ‡ observes that in *Tropidonotus natrix* and *Coluber æsculapii* there is no direct connection between the abdominal and the renal afferent veins. I can quite confirm this by the conditions observable in *Zamenis*

* I did not ascertain this measurement.

† Ann. Sci. Nat. (4) vi. p. 321.

‡ Morph. Jahrb. xix. p. 489.

gemonensis. I take it that the posterior bifurcation of the anterior abdominal vein in the last-mentioned Colubrine snake (and possibly in *Causus* and other forms) is a reminiscence of its former origin by two roots from the renal afferent veins as in the less modified Lacertilia, and, as I have already shown, in the especially "Saurian" *Eryx jaculus* and *Eryx johni*.

It is clear from the foregoing, that the somewhat divergent opinions of previous authors are partly due to actual differences in the abdominal and afferent renal veins of different Ophidia, to our knowledge of which I have been able to add something. It is furthermore clear that the Boidæ contrast with other Ophidia, so far as observation has gone, in their greater approximation to the Saurian type of organisation; they are, in fact, more primitive than other Ophidia. In these Ophidia alone is the anterior abdominal vein connected with one or both of the afferent renals, and in them there is generally doubling of the anterior abdominal vein in front of the junction of its constituent veins. Of all the Boidæ whose anatomy is known, *Eryx jaculus* (not *E. conicus*) comes nearest to the Saurian type in that its anterior abdominal vein arises from two distinct roots, one from each of the renal afferent veins.

§ Remains of Cardinal Veins.

In comparing the venous system of the adult *Tropidonotus* with that of the adult *Lacerta*, Dr. Hochstetter* arrived at the conclusion "dass das Venensystem der Lacerta auf einer etwas niederen Entwicklungsstufe stehen geblieben ist als das von Tropidonotus. Bei Lacerta ist das System der Vertebralvenen noch erhalten, während es bei Tropidonotus nahezu völlig geschwunden ist." Hochstetter's statements are also accurate when applied to other Colubrine snakes. I have examined *Lioheterodon madagascariensis* with some care from this point of view. In that snake there is hardly any development of vertebral veins, such as I shall describe immediately in the Boidæ. About halfway down the liver, however, is a longitudinal vessel running for a short distance, from which arises a tributary to the hepatic portal system. Another Colubrine snake, viz. *Zamenis gemonensis*, showed an interesting persistence of a portion of the posterior cardinal vein precisely comparable to what is to be found in the Chamæleon† and in *Pygopus*‡. The afferent renal artery in front of the left kidney, instead of ending, as is usual, towards the anterior end of that gland, passes beyond it and imbeds itself in the body-wall to the left of the median dorsal line. I could find nothing to correspond on the right side. If really absent—and I am convinced that there is at least nothing really conspicuous—this is another example of the asymmetry of Ophidian

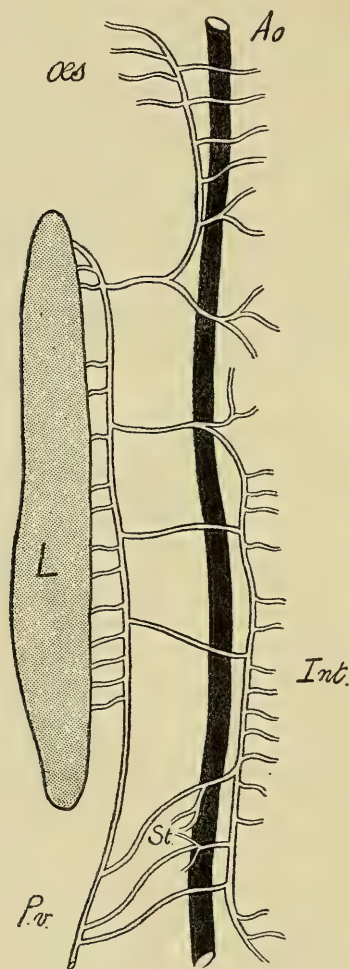
* Morph. Jahrb. xix. p. 493.

† Hochstetter, *loc. cit.* p. 462, and Beddard, *loc. cit. infra*.

‡ Beddard, "Contributions to the Anatomy of the Lacertilia, No. 3," P. Z. S. 1904, vol. ii. p. 12.

structure. The discovery of this prerenal portion of the posterior cardinal in an Ophidian removes another point of dissimilarity between the Ophidia and the Lacertilia.

Text-fig. 23.

Liver and certain adjacent veins in *Eryx conicus*.

Ao., aorta; *oes.*, oesophageal branches of longitudinally running left posterior cardinal; *Int.*, intercostal branches of the same; *L*, liver; *P.v.*, portal vein; *St.*, branches to stomach.

The *Azygos* vein is admittedly a vestige of the posterior cardinal

of its side. This vessel appears to be well developed in some Boid serpents, and that fact appears to me to indicate the retention of a primitive feature*. In *Eryx jaculus*, for example, the vein, which is on the right side, extends back over no less than twelve intercostal spaces and nearly reaches the junction of the two aortæ. This contrasts with the same vein in *Coronella getula*, which only extends over four of these spaces. In a specimen of *Eryx conicus* the azygos vein extended only over ten vertebræ. In both specimens of *Eryx conicus* the azygos, after a break, reappeared in the region of the liver, where its course is shown in the accompanying drawing (text-fig. 23, p. 118). It will there be seen that the vertebral vein with one gap near the anterior end of the liver runs continuously to a point some little distance behind the liver. It gives off branches on the one hand to the dorsal parietes, and on the other to the portal vein. Anteriorly to the liver the branches go to the œsophagus. In *Eryx jaculus* (text-fig. 20, p. 110, *C.v.l.*, *C.v.r.*) there were conspicuous traces of both posterior cardinals behind the liver. As will be seen in the drawing referred to, the left posterior cardinal is continued anteriorly beyond its junction by a conspicuous branch with the portal trunk in the immediate neighbourhood of the liver; posteriorly it ends near to the commencement of the right-hand vein, the two being therefore supplementary to each other. The left is considerably the longer. The right extends back a little way beyond the origin of the superior mesenteric artery from the aorta. In *Python sebae* a corresponding vein occurs in the region of the liver, but it extends both further forward and backward than I have observed in *Eryx*. Anteriorly it extends beyond the junction of the two aortæ, and posteriorly it reaches very nearly to the gall-bladder. I do not for the present suggest that these longitudinal vessels are more developed in the Boidæ. I simply call attention to their arrangement.

§ *On the Specific Differences between Eryx jaculus, E. johni, and E. conicus.*

These species can be readily separated by external characters, as Boulenger plainly sets forth in the British Museum 'Catalogue of Snakes.' They also, however, differ in other points besides the obtuse or pointed tail, the absent or present mental groove, and the form of the rostral scale, &c.

There are differences, in the first place, in the form of the liver. In *Eryx jaculus* and *E. johni* the lobes are unequal, and the right lobe extends further down the body than the left, to the extent of about half an inch. In *Eryx conicus* they are as near as possible exactly equal. As these results depend upon the examination of two examples of each of the species *E. jaculus* and

* As I have pointed out in a preliminary account of some of the facts detailed in the present communication (Ann. & Mag. Nat. Hist. (7) xiii. p. 233).

E. conicus, the character may, I take it, be regarded as a genuine, if small, difference.

Secondly, the right lobe of the lung extends further back in *Eryx jaculus* and *E. johni*. In those species it reaches the gall-bladder; in *Eryx conicus* it falls short of the gall-bladder by at least an inch.

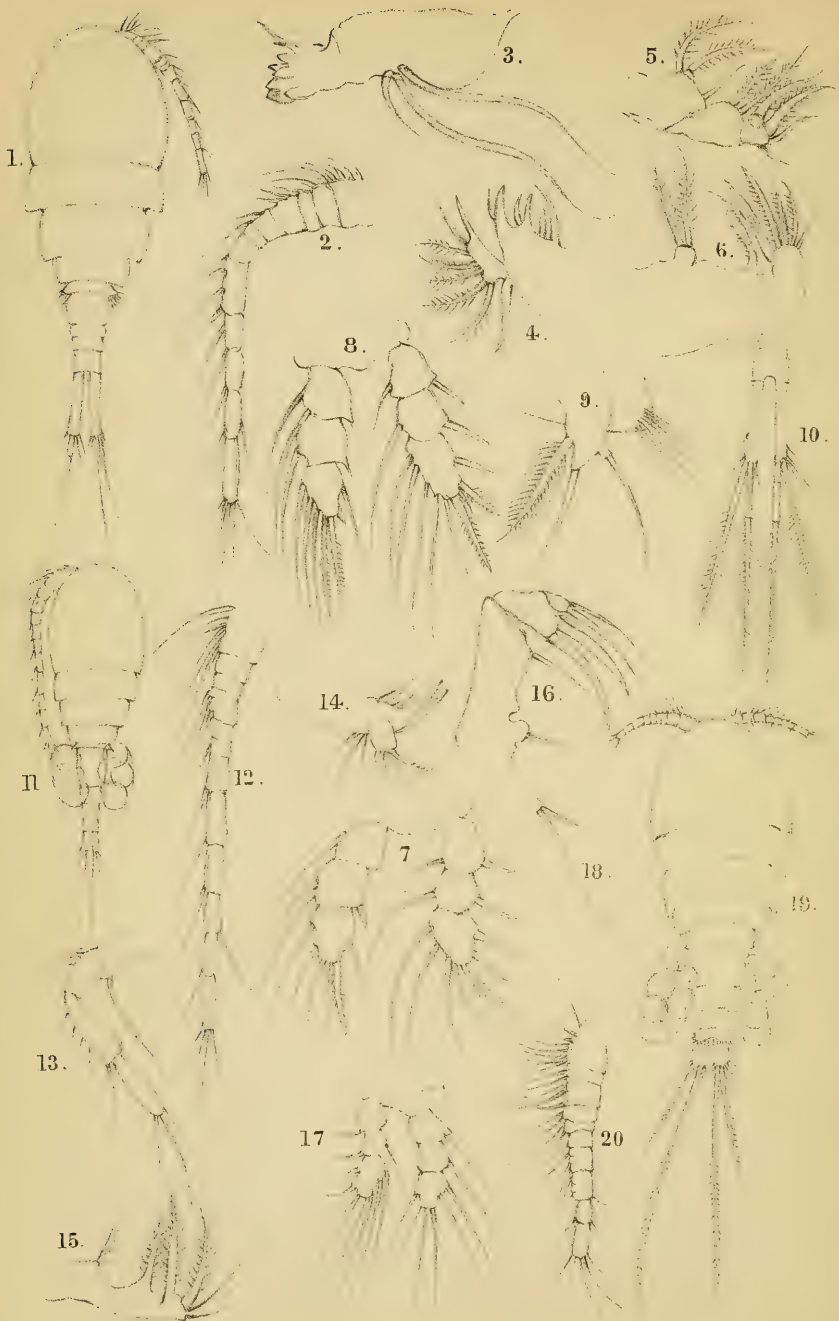
The superior mesenteric artery arises in *Eryx jaculus* and *E. johni* distinctly in front of the gall-bladder. In *Eryx conicus* its point of origin is as distinctly behind the gall-bladder. This character is perhaps less likely than some others to prove of value as an absolute mark of distinction.

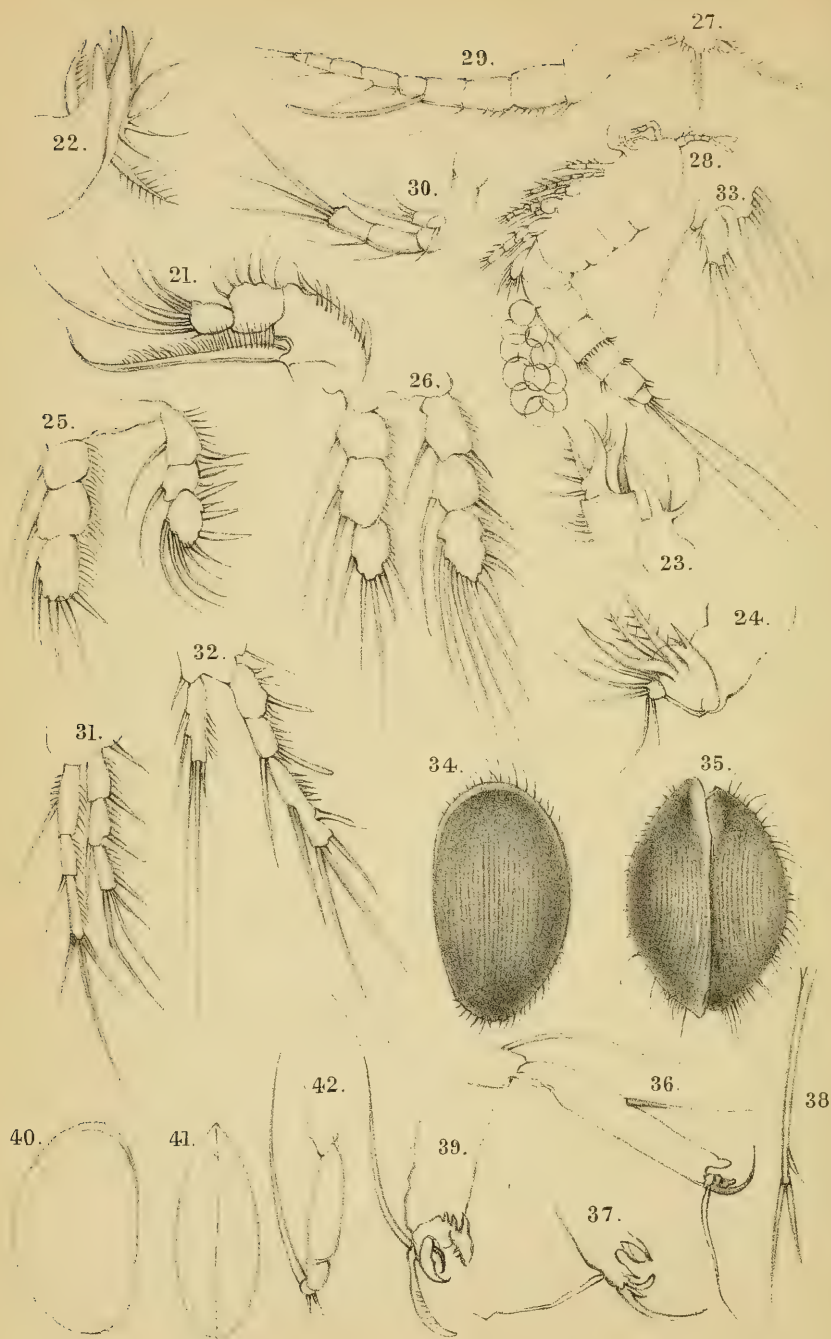
More important are other differences in the vascular system. In *Eryx jaculus*, though it is the smaller species, there are apparently, as a rule, two arteries supplying each kidney; in *Eryx conicus* there is but one to each kidney: and here apparently *E. johni* agrees with *E. conicus*. The intercostal arteries have a different arrangement in the two species. In *E. jaculus* there is a well-developed posterior vertebral artery formed by the junction of irregularly arising intercostals; in *E. conicus* this does not exist (except as the merest rudiment). The paired intercostals commence further forward in *E. jaculus* than in *E. conicus*. *E. johni* in these particulars is somewhat intermediate. In *E. jaculus* there is a double connection of the anterior abdominal vein with the afferent renals posteriorly; in *E. conicus* this occurs only on one side. *E. johni* agrees with *E. jaculus*. In relation to these anatomical differences, which appear to me to be fully as great as those which distinguish either species from *Eunectes*, I would draw attention to the restricted range of *E. conicus* and to the wider distribution of *E. jaculus* and *E. johni*.

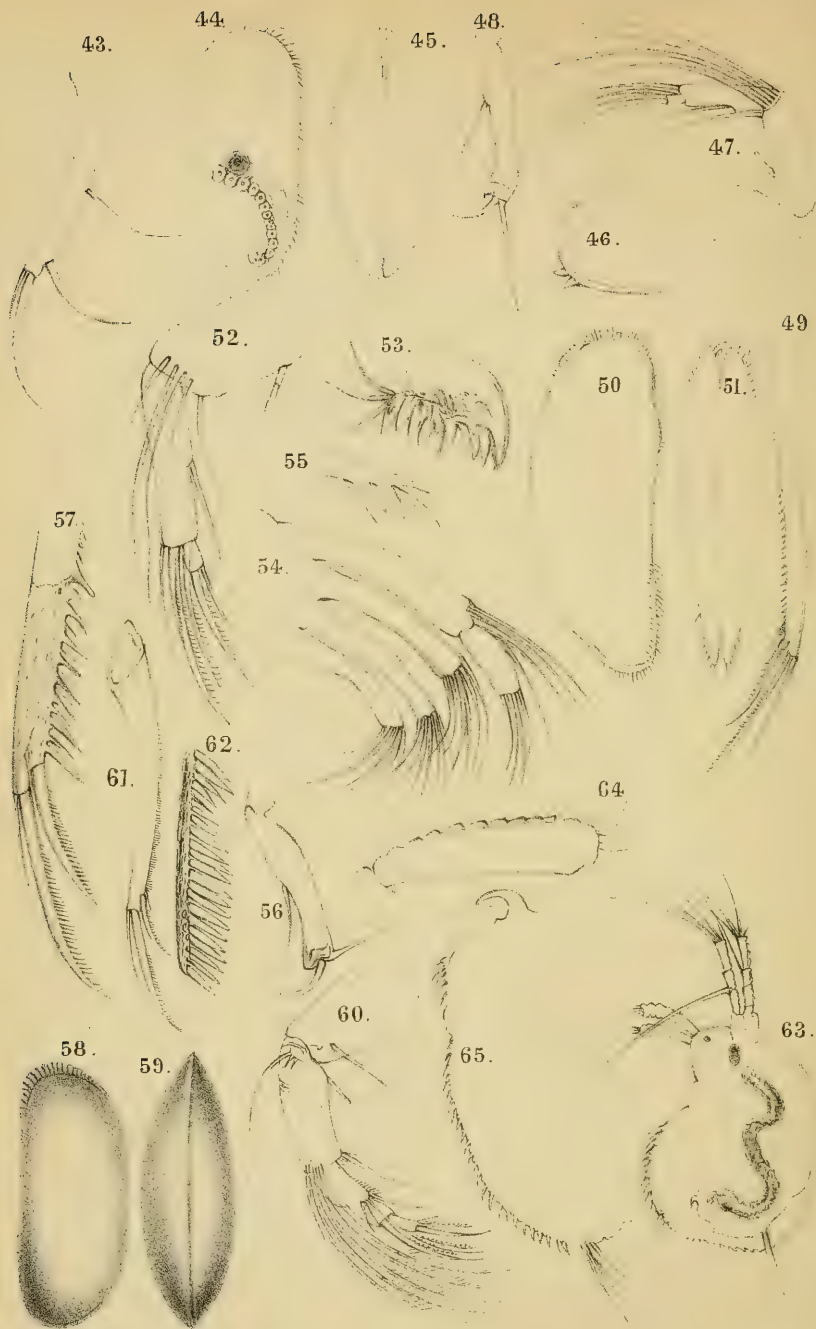
Résumé of principal facts.

It may be convenient to deduce from the foregoing pages the main facts in the vascular system of the Boidæ examined; such may be divided into two heads, *i. e.*, those which appear to argue a basal position among the Ophidia, and those which are of systematic importance in the group. As to the former it may be noted that

- (1) The heart is always without the least trace of a gubernaculum cordis.
- (2) The two aortæ are usually equisized at their point of union to form the dorsal aorta.
- (3) The renal and gastric arteries are much fewer in number than in other Ophidia, the former consisting generally of only one artery to each kidney. This distribution has no relation to the size of the kidney.
- (4) The intercostal arteries are always symmetrical and for the most part regular in their arrangement, frequently in regular pairs.







- (5) The anterior abdominal vein always arises from one afferent renal, rarely from both as in the Saurians. Frequently, also, it is double.
- (6) The existence of veins continuing the azygos posteriorly is usual.

Facts which are of importance for the systematic arrangement of genera and species within the family Boidæ:—

- (1) The Boinæ (*Eunectes* and *Eryx*) differ from the Pythoninæ (*Python*) in that the intercostals are posteriorly paired arteries, while in the Pythoninæ a single median artery divides into two close to the median dorsal line throughout the series.
- (2) The three species *Eryx conicus*, *E. johnei*, and *E. jaculus* differ from each other in a large number of anatomical features.

Besides these points several other anatomical features are of interest as new or rare among Ophidia. Such are

- (1) The continuation of the afferent renal of the left kidney in *Zamenis gemonensis* beyond the kidney into the parietes, as in *Chamaeleon* and *Pygopus*.
- (2) The origin of œsophageal arteries not only from the left aortic arch but from some of the intercostals of the right half arch.
- (3) The fusion of some of the anterior intercostals in *Eryx jaculus* (and *Python spilotes*) to form a continuous longitudinal trunk lying dorsally of the aorta.
- (4) Representatives of the lateral abdominal vein of Lizards appear to exist in certain snakes (e.g. *Eunectes* and *Eryx*).
- (5) Origin of a fat-body artery in *Eryx johnei* from an intercostal.

4. On Entomostraca collected in Natal by Mr. James Gibson.

By G. STEWARDSON BRADY, M.D., LL.D., D.Sc., F.R.S.,
C.M.Z.S.

[Received March 25, 1904.]

(Plates VI.–VIII.*)

For the opportunity of examining and describing these species I am indebted to the kindness of Mr. James Gibson, Resident Magistrate at Greytown, by whom they were collected in the summer of 1902. All are freshwater species, and were found in pools in the neighbourhood of Greytown, Natal. The identity of some of them with European forms is a point of considerable interest, and indeed the general aspect of the gatherings is quite

* For explanation of the Plates, see p. 127.

similar to what one would expect in ordinary Northern collections. With the exception of one species, for which I have thought it best to propose a new generic name—*Ectocyclops*—all are referable to familiar European genera.

CYCLOPS LEUCKARTI Claus.

This appears to be less plentiful in the Natal gatherings than any of the following species, though more conspicuous owing to its greater size.

The form described by me years ago under the specific name *scourfieldi** has been identified by other authors (Lilljeborg, Herrick, Schmeil) with *C. leuckarti* Claus. I am doubtful as to the correctness of this identification. Both Schmeil† and Herrick‡ figure, with differences, peculiar pellucid marginal laminae on the last two joints of the larger antennae. I have been unable to detect any such structure in my British specimens of *C. scourfieldi*, neither does it exist in the Natal specimens nor in others from Ceylon which I refer to the same species. And it may be noted that Lilljeborg, while accepting Schmeil's description and figures as belonging to *C. leuckarti*, does not himself refer in his definition to these antennal laminae. Herrick, on the other hand, figures and describes them, and expresses a doubt as to the identity of the species with *C. scourfieldi*. I do not myself possess authentic specimens of *C. leuckarti*, and must be content for the present to leave the question in suspense.

CYCLOPS PUSILLUS, n. sp. (Plate VI. figs. 11–18.)

Female. Body slender, tapering gradually from before backwards (fig. 11); thoracic segments not produced at the angles, except the last which is extremely short and angulated: abdomen very slender, the first segment nearly as long as the united lengths of the following three segments; furcal segments slender, scarcely longer than the preceding abdominal segment; principal tail-seta nearly as long as the whole abdomen. Ovisacs closely adpressed to the abdomen and containing only a few comparatively large eggs. Antennules twelve-jointed, slender, somewhat longer than the entire cephalothorax, bearing numerous long setae (fig. 12). All the branches of the first four pairs of feet three-jointed; spines of the first pair (fig. 17) very slender and setiform; fifth pair (fig. 18) rudimentary, almost obsolete, consisting of a minute papilla from which arise two unequal setae. Length, exclusive of tail-setae, 0.46 mm.

This is the smallest species of *Cyclops* with which I am acquainted. But its general development and the fact of many specimens bearing ova, indicate that it is not an immature form.

* Brady, G. S. "A Revision of the British Species of Freshwater Cyclopidae and Calanidae" (Nat. Hist. Trans. Northumberland & Durham, vol. xi., 1891).

† Schmeil, Deutschlands freilebende Süßwasser-Copepoden. 1 Teil, Cyclopidae. 1892.

‡ Herrick, Synopsis of the Entomostraca of Minnesota, 1895.

CYCLOPS GIBSONI, n. sp. (Plate VI. figs. 1-10.)

Female. Seen dorsally the outline is slender, gradually tapering from before backwards, greatest width equal to about one-third of the length (fig. 1); the second segment as wide as the cephalic segment, slightly produced and angulated posteriorly, third segment narrower and scarcely at all produced at the angles, fourth segment again narrower and without produced angles; last thoracic segment about as wide as the fourth from side to side, but much narrowed from before backward, its lateral angles distinctly produced and bearing a brush of six or eight rather long setæ; abdominal segments gradually tapering backwards, the combined lengths of the second and third equal to that of the fourth, first segment rather larger than the fourth; caudal stylets slender (fig. 10), nearly equal in length to the abdomen, about five times as long as broad; the innermost of the two apical setæ is the longer and is about equal in length to the entire abdomen, outer setæ somewhat shorter; the subsidiary setæ are three in number, short, subequal, and arise from the apices of the stylets; on the side of each stylet not far from the distal end is a single very minute seta; the larger setæ are very finely plumose. The antennules are twelve-jointed (fig. 2), slender, bearing numerous setæ, and reach backwards as far as to the front of the second segment: the proportionate lengths of the joints are indicated in the following formula:—

1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.
3	1½	1	2	1½	1	2	4	3	3	3½	4.

The mandible is of the usual form, with a rudimentary palp of three setæ, two long and one short (fig. 3); the chewing portion of the maxilla (fig. 4) is of normal shape, with a laminar palp bearing several plumose setæ. The rami of the first four pairs of feet are all three-jointed; terminal joint of the outer branch of the first pair bearing two slender spines on the outer margin, three long setæ on the inner margin and two shorter apical setæ, the outermost being finely bipectinate (fig. 7); the terminal joint of the inner branch has one long apical spine and on its outer margin one very short spine and one slender seta, its internal margin has three setæ and one at the apex. The second, third, and fourth pairs (fig. 8) are nearly similar, but with more elongated joints and more robust spinous armature. The fifth pair (fig. 9) is uniarticulate, with three subequal setæ, the innermost of which is densely plumose. Length 1 mm.

Among European species those most nearly allied to *C. gibsoni* seem to be *C. varicans*, *C. bicolor* G. O. Sars and *C. gracilis* Lilljeborg; but all of these have the rami of the swimming-feet uniformly biarticulate, whereas in *C. gibsoni* they are triarticulate.

CYCLOPS FIMBRIATUS Fischer.

This appears to be one of the commonest species in Mr. Gibson's

collection, agreeing down to the minutest details with British specimens.

ECTOCYCLOPS, nov. gen.

Like *Cyclops* except that the mandibles, maxillæ, and maxillipeds are less fully developed and are very indistinctly jointed, the posterior antenna bears a very stout ciliated seta on the posterior margin, and the terminal joints of the rami of the swimming-feet are scarcely at all elongated.

ECTOCYCLOPS RUBESCENS, n. sp. (Plate VI. figs. 19-20; Plate VII. figs. 21-27.)

Female. Body depressed, rather robust (fig. 19); cephalothoracic segments not produced laterally; abdominal segments short and stout, posterior margin of the last segment pectinated, furcal segments not much longer than broad; principal tail-setæ marginally aculeated, the innermost nearly equalling three-fourths of the length of the body; ovisacs large and adpressed. Antennules (fig. 20) ten-jointed, much shorter than the first cephalothoracic segment, and rather densely setiferous; antennæ (fig. 21) robust, anterior margin fringed towards the base with numerous short setæ, penultimate joint with about six larger setæ, terminal joint with several longer setæ; on the posterior margin rising from the base of the second joint is a very long and stout ciliated appendage. Mandibles bearing a rudimentary palp consisting of three very small setæ; maxillæ (fig. 22) not much different from those of *Cyclops*; anterior and posterior maxillipeds (figs. 23, 24) small, stout, and indistinctly jointed, the marginal curved teeth of the anterior pair very robust; rami of the swimming-feet three-jointed (figs. 25, 26), fifth pair obsolete, represented only by three short plumose setæ (fig. 27). Colour of the posterior part of the body faint reddish-brown, the anterior part nearly colourless (in spirit specimens). Length 0.85 mm.

ATTHEYELLA NATALIS, n. sp. (Plate VII. figs. 28-33.)

Female. In general outline like *Canthocamptus* (fig. 28). First thoracic segment coalescent with the head; posterior abdominal segments spinulose on the hinder margin; furca very short; principal tail-setæ equal to at least half the length of the body. Antennules slender, nine-jointed (fig. 29), shorter than the first cephalothoracic segment, and very sparingly setiferous; antennæ (fig. 30) bearing a minute one-jointed secondary branch. First pair of swimming-feet (fig. 31) short, both branches three-jointed, outer about equal in length to the first two joints of the inner branch; second, third, and fourth pairs having the outer branch composed of three, the inner of one joint (fig. 32); fifth pair (fig. 33) foliaceous, two-jointed, basal joint wide and bearing four long setæ on its inner and one on the outer lobe, terminal joint ovate and bearing three unequal apical setæ. Length 0.75 mm.

CYPRIA CASTANEA, n. sp. (Plate VII. figs. 40-42; Plate VIII. fig. 43.)

? *Cypria lacustris* Lilljeborg.

Shell, seen from the side, subovate (almost semicircular), highest in the middle, height equal to nearly two-thirds of the length (fig. 40); extremities broadly rounded, the anterior bordered by a narrow translucent fillet, dorsal margin boldly and evenly arched, ventral nearly straight: seen from above (fig. 41) the outline is narrowly ovate, widest behind the middle, width equal to more than one-third of the length, tapered to an acute point in front, rounded behind. Surface perfectly smooth and polished; colour reddish-brown, without any trace of hairs or sculpture. Length 0.65 mm. Limbs closely resembling those of *C. ophthalmica*, but much more slender, both as regards bulk and armature (figs. 42, 43.)

This seems to me to approach most nearly to *C. lacustris* Lilljeborg, if indeed that be truly a distinct species, and there is not much to separate it from the common Northern species *C. ophthalmica*, except the absence of shell-markings and the much more slender build of the limbs, of the post-abdominal claws, and of the antennal setæ. The specific name now proposed must, however, be looked upon as merely provisional.

CYPRIS INERMIS, n. sp. (Plate VIII. figs. 44-49.)

Shell, seen from the side, oblong-ovate (fig. 44), rather higher in front than behind, height equal to less than one-half the length, dorsal margin gently arched, ventral slightly sinuated; anterior extremity evenly rounded, posterior very much narrower and rounded; extremities and ventral margin fringed with fine hairs: seen from above (fig. 45) the outline is ovate, greatest width about equal to the height and situated near the middle, lateral margins evenly arcuate, extremities evenly rounded, the anterior rather the broader of the two. In young specimens the postero-inferior angle of the right valve bears two sharp teeth (fig. 46). Colour of the shell greyish white. Length 0.95 mm.

The antenna (fig. 47) bears a brush of four setæ which reach as far as the extremities of the very slender terminal claws. Apex of the second foot bearing a single slender curved claw (fig. 48) and a long seta. Post-abdominal rami (fig. 49) long and slender, finely ciliated on the hinder margin; all the setæ slender and crowded together apically, of these two are stouter than the rest and marginally pectinated.

This species occurred abundantly in one of Mr. Gibson's gatherings, less plentifully in another.

CYPRIS ARATRA, n. sp. (Plate VII. figs. 34-38.)

Shell, seen from the side (fig. 34), subovate, highest in the middle, height equal to more than half the length; anterior extremity broadly and rather obliquely rounded, posterior much narrower

and less distinctly rounded off; dorsal margin boldly arched, sloping more steeply behind than in front, ventral feebly convex, with no trace of sinuation: seen from above (fig. 35) the outline is very broadly ovate, widest in the middle, width equal to nearly three-fourths of the length, extremities obtusely pointed, the left valve larger and overlapping the right both in front and behind. Surface of the shell marked throughout with delicate and closely-set longitudinal furrows and bearing scattered hairs of variable length. Colour dusky greenish grey. Length 1.0 mm.

The antennæ bear fascicles of setæ reaching to the extremity of the claws, exactly as in the preceding species; second pair of feet with a slender terminal claw (figs. 36, 37), one long seta and several small claw-like processes*; post-abdominal rami (fig. 38) extremely slender, bearing two apical setæ and one much smaller lateral seta situated not very far from the apex.

The armature of the second pair of feet is here very different from that of a typical *Cypris*, but this character seems insufficient to give it separate generic rank.

STENOCYPRIS PERARMATA, n. sp. (Plate VIII. figs. 50–57.)

Shell, seen from the side (fig. 50), elongated, siliquose, greatest height equal to rather more than one-third of the length and situated in the middle; anterior extremity evenly rounded, posterior suddenly tapered, narrow and rounded off below; dorsal margin arcuate, sloping evenly toward the front, more abruptly and with a slight sinuosity behind, ventral slightly sinuated near the front but having a longer, shallow sinuation in the middle: seen from above (fig. 51) the outline is extremely compressed and elongated, quite four times as long as broad, obtusely pointed in front, acuminate behind. Surface smooth, slightly setiferous at the extremities; structure thin and membranaceous†. Length 1.6 mm.

Antepenultimate joint of the antennæ (fig. 52) bearing a small fascicle of setæ, two of which are longer than the rest, reaching beyond the bases of the terminal claws; mandibles (fig. 53) of the usual form, the biting portion armed with numerous strong teeth; maxillæ (fig. 54) having four slender, elongated lobes, two of the claws of the second lobe strongly denticulate (fig. 55); terminal claw of the first foot very long and slender, second foot (fig. 56) bearing a falcate terminal claw and a very long seta; post-abdominal rami (fig. 57) slender, bearing two long, strongly pectinated terminal claws and one very slender seta, and on the dorsal margin towards the apex armed with a series of about nine or ten strong spines with smaller setæ in the intervals; genital lobes very similar to those of *Herpetocypris* and other parthenogenetic Cyprididæ.

* The second foot of *Cypris ornata*, a rare British species, is very similar to this, and is figured in Plate VII. fig. 39.

† The specimens, as I received them, had been for a length of time in a formalin preservative, which may perhaps have led to the disappearance of calcareous structures.

This interesting species seems to occupy an intermediate position between *Herpetocypris* and *Stenocypris* so far as the antennal setæ, at least, are concerned, but from the shell-characters alone one would undoubtedly assign it to *Stenocypris*. Professor G. O. Sars in his description of *S. chevreuxii* mentions the "partly denticulated" spines of the lobes of the first pair of maxillæ, but does not figure them, and the antennal setæ of that species are certainly much more fully developed both as to length and number than in *S. perarmata*. These points I have been able to confirm from an examination of British specimens of *S. chevreuxii*, which I have been fortunate enough to find in several localities:—very sparingly in a pond at Pike's Hill, and in the Hatchet Pond, both near Lyndhurst, and more recently in considerable quantity in ditches near the River Arun at Arundel, Sussex. Figures of the shell, antenna, and post-abdomen of *S. chevreuxii* are given in Plate VIII. figs. 58–62.

MACROTHRIX AFFINIS, n. sp. (Plate VIII. figs. 63–65.)

Body short, length about one-third greater than the breadth (fig. 63). Head short and obtuse, with a rounded angle to which the antennules are attached; dorsal margin gently arched, obscurely angulated at its junction with the posterior margin which is finely denticulated, ventral margin convex and fringed with rather long hairs: antennules (fig. 64) club-shaped, slightly dilated and truncated distally, crenulated on the outer margin which bears a few cilia, as also does the truncated extremity. Post-abdomen (fig. 65) spinulose along the whole of its posterior border and having a short terminal hooked claw. The antennæ have the normal structure, not presenting any special characters, nor does the shell exhibit any definite ornament or sculpture. Length 0.32 mm.

This is a very small species, and is not very unlike the Northern *M. laticornis*, though only about half its size.

EXPLANATION OF THE PLATES.

PLATE VI.

Cyclops gibsoni, ♀, p. 123.

- | | |
|--------------------------|----------------------------|
| Fig. 1. Seen from above. | Fig. 6. Posterior footjaw. |
| 2. Antennule. | 7. Foot of first pair. |
| 3. Mandible. | 8. Foot of third pair. |
| 4. Maxilla. | 9. Foot of fifth pair. |
| 5. Anterior footjaw. | 10. Furca. |

Cyclops pusillus, ♀, p. 122.

- | | |
|---------------------------|----------------------------|
| Fig. 11. Seen from above. | Fig. 15. Anterior footjaw. |
| 12. Antennule. | 16. Posterior footjaw. |
| 13. Antenna. | 17. Foot of first pair. |
| 14. Maxilla. | 18. Foot of fifth pair. |

Ectocyclops rubescens, ♀, p. 124.

- | | |
|---------------------------|---------------------|
| Fig. 19. Seen from above. | Fig. 20. Antennule. |
|---------------------------|---------------------|

PLATE VII.

Ectocyclops rubescens, ♀, p. 124.

Fig. 21. Antenna.

22. Maxilla.

23. Anterior footjaw.

24. Posterior footjaw.

Fig. 25. Foot of first pair.

26. Foot of third pair.

27. Foot of fifth pair.

Attheyella natalis, ♀, p. 124.

Fig. 28. Seen from left side.

29. Antennule.

30. Antenna.

Fig. 31. Foot of first pair.

32. Foot of third pair.

33. Foot of fifth pair.

Cypris aratra, p. 125.Fig. 34. Shell seen from left side. } $\times 50$.

35. Shell seen from above. }

36. Extremity of second foot.

Fig. 37. The same more highly magnified.

38. Post-abdominal ramus.

Cypris ornata, p. 126.

Fig. 39. Extremity of second foot.

Cypria castanea, p. 125.

Fig. 40. Outline of shell seen from right side.

Fig. 41. Outline of shell seen from above.

42. Extremity of second foot.

PLATE VIII.

Cypria castanea, p. 125.

Fig. 43. Post-abdominal ramus.

Cypris inermis, p. 125.

Fig. 44. Shell seen from right side.

45. Shell seen from above.

46. Posterior extremity of young shell.

Fig. 47. Antenna.

48. Extremity of second foot.

49. Post-abdominal ramus.

Stenocypris perarmata, p. 126.

Fig. 50. Shell seen from right side.

51. Shell seen from above.

52. Antenna.

53. Mandible (chewing-end).

54. Maxilla of first pair.

Fig. 55. Maxilla, spiniferous tooth more highly magnified.

56. Extremity of second foot.

57. Apex of post-abdominal ramus.

Stenocypris chevreuxii, p. 127.

Fig. 58. Shell seen from left side.

59. Shell seen from above.

60. Antenna.

Fig. 61. Post-abdominal ramus.

62. Group of marginal setæ of the same.

Macrothrix affinis, p. 127.

Fig. 63. Seen from left side.

64. Antennule.

Fig. 65. Post-abdomen.

June 7, 1904.

F. DU CANE GODMAN, Esq., D.C.L., F.R.S., Vice-President,
in the Chair.

The Secretary read the following report on the additions that had been made to the Menagerie in May 1904 :—

The number of registered additions to the Society's Menagerie during the month of May was 276. Of these 102 were acquired by presentation and 97 by purchase, 8 were born in the Gardens, 61 were received on deposit and 8 in exchange. The number of departures during the same period, by death and removals, was 132.

Amongst the additions attention may be called to the following specimens, all new to the Collection :—

1. Three Andaman Banded Crakes (*Rallina canningi*), presented by the Government of India on May 2nd.

2. A Yellow-handed Howler (*Mycetes beelzebul*), received on deposit on May 13th.

3. An Antilopine Kangaroo (*Macropus antilopinus*), received on deposit on May 14th.

4. A Grey Solitaire (*Myiadectes unicolor*), received on deposit on May 30th.

The Secretary reported that he had recently paid a visit to Paris to inspect two specimens of the Orang-utan (*Simia satyrus*) which had been offered for sale to the Society. He stated that they were very fine animals and fully adult, one of them standing over five feet in height and the other not much less, the former being the largest he had ever seen either living or stuffed. Although they were savage he was able to feed them from the hand with boiled rice, which constituted their chief food. Owing to his opinion that they were in indifferent health he did not purchase them*.

Dr. Günther, F.R.S., Vice-Pres.Z.S., on behalf of the President, exhibited a series of hybrid Pheasants killed at various times in the coverts at Woburn, where specimens of many distinct species had been turned out into the open. He stated that nothing of a definite nature was known as to their parentage, but proposed the following determinations tentatively :—

1. Reeves's Pheasant (*Phasianus reevesi*) × Common Pheasant.

2. Reeves's Pheasant × Elliot's Pheasant (*Ph. ellioti*). An old female assuming male plumage.

* [I have been informed that both the Orangs died within a few days of my seeing them.—P. C. M.]

3. Common Pheasant \times Amherst's Pheasant (*Tharimalea amherstiae*). Male.

4. Common Pheasant \times Amherst's Pheasant. Old female.

5. Cheer Pheasant (*Ph. wallichii*) \times Common Pheasant (? Elliot's Pheasant). Male.

6. Cheer Pheasant \times Common Pheasant. Male.

7. Silver Pheasant (*Gennæus nycthemerus*) \times Elliot's Pheasant. Male.

8. Lineated Kaleege (*G. lineatus*) \times Common Pheasant. Male.

9. Lineated Kaleege \times Japanese Pheasant (*Ph. versicolor*). Male.

10. Cheer Pheasant \times ? Himalayan Monaul (*Lophophorus impeyanus*). Male.

Dr. F. D. Drewitt, F.Z.S., exhibited two fine antlers of the North-African Red Deer (*Cervus elaphus barbarus*) and made the following remarks:—

“These antlers were obtained in the high forest-land of cork, oak, and cedar, extending far inland on the borders of Tunis and Algeria.

“One of the most interesting links between the fauna of North Africa and Europe is this Red Deer living among lions and panthers.

“Barbary-Deer antlers differ from typical Red-Deer antlers in having no second tine. This seems a constant characteristic. In other heads seen in Algeria it was absent. It is absent in a specimen from Algeria in the Cambridge Museum; also in two Menagerie specimens in the Natural History Museum (one from the Gardens and one given by the Duke of Bedford).

“Few Englishmen have seen a wild Barbary Stag. Sir Harry Johnston is one of the few. He reports that twenty-four years ago it was fairly common throughout the forest. Now, though protected by the French Government, it is rare; forest fires and poaching Arabs have almost exterminated it—but a few remain. Fortunately a wild stag among trees, facing its enemy, is sometimes almost invisible at a few feet, the antlers exactly copying not only the form of a branch but also the bark on it.”

Dr. Drewitt also exhibited a pair of horns ($15\frac{1}{2}$ inches in length) of Loder's Gazelle (*Gazella leptoceros*) from South Algeria.

Some photographs, sent by Dr. Graham Renshaw, F.Z.S., of a pair of Short-horned Buffaloes in the Antwerp Zoological Gardens, were exhibited, and the following note upon them, contributed by Dr. Renshaw, was read:—

“The difficulty experienced by naturalists in separating the

geographical species or races of the Short-horned African Buffaloes may render interesting the accompanying photographs, taken by myself, of a pair of Short-horned Buffaloes which have lived for many years in the Antwerp Zoological Gardens. Seen sideways, the horns of both specimens sloped back almost in the plane of the forehead. Seen from the front, the horns of the bull were broad and flattened, without transverse markings, and with but a small development of the boss, which forms a ring-like projection where the horn springs from the skull. The horns bore considerable resemblance to those of the Senegambian Buffalo (*Bos caffer planiceros*), and perhaps the animal is referable to this subspecies. The horns of the cow, however, were more curved at the tips, and recalled those of the Lake Tchad Buffalo (*Bos caffer brachyceros*). Both animals were in the prime of life, of a deep dark blackish-brown colour; the edges of the ears were heavily fringed with hair, but there was no hair inside the pinna. A very sparse line of hair (the individual hairs being about 4 inches long) extended from the occiput to the root of the tail. The tail was very dark brown; tail-tuft black. The dorsal line of hair was hardly noticeable in the cow. The animals were labelled '*Bubalus pumilus*, Afr. Australe et Centrale (Buffle nain du Sénégal).' However, they do not agree at all with *Bos caffer nanus* (Bush-Cow of the West Coast sportsmen)."

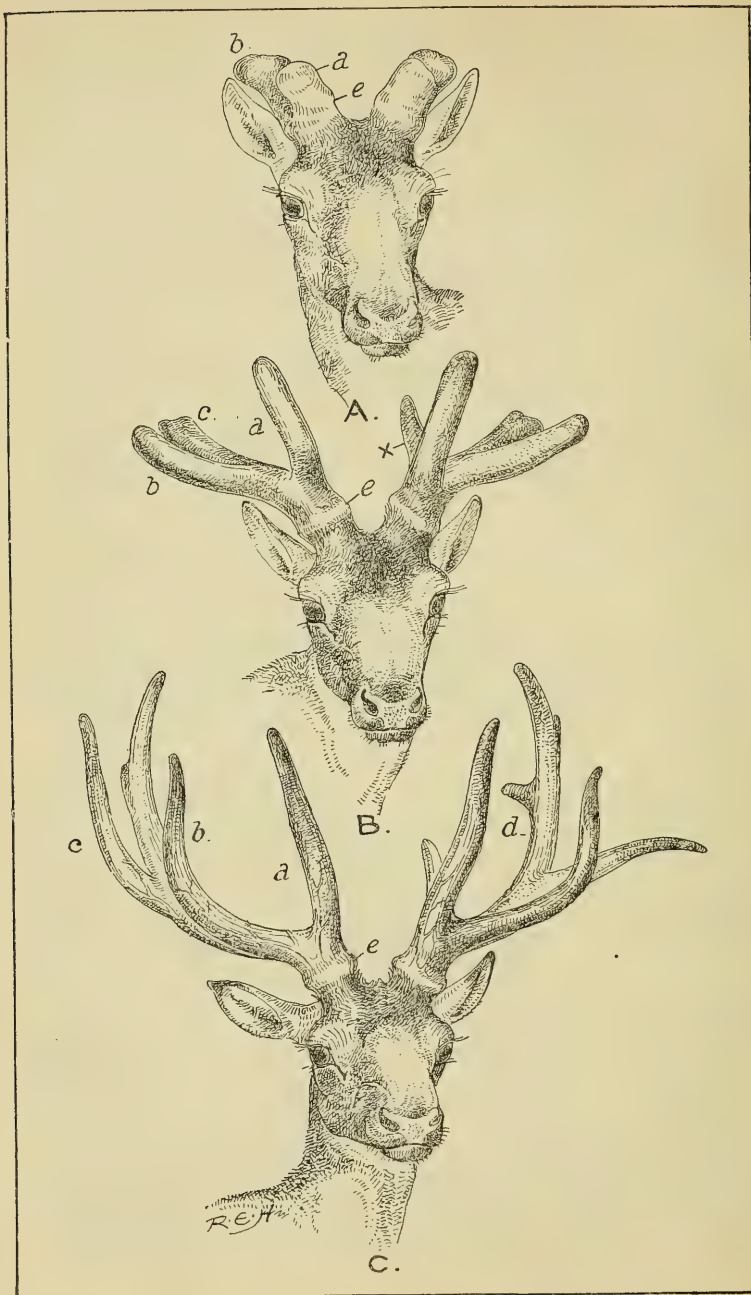
Mr. F. E. Beddard, F.R.S., exhibited and made remarks upon the skull of the Cape Crowned Crane, *Balearica chrysopelargus*, showing paired lateral and single median bony bosses suggestive of those of horn-bearing vertebrates.

Mr. R. E. Holding exhibited and made remarks upon a series of 12 platinotype photographs, three of which are here reproduced (text-fig. 24, p. 132), taken by Mr. Henry Irving, of Horley, showing the growth and development of the horns in the Wapiti Stag (*Cervus canadensis*) bred by the Society and now living in the Gardens. The first of the series was taken on March 20th, 1903, the date on which the horns were shed, and photographs were taken at fortnightly intervals until the following September, when the horns were fully adult and almost free from the velvet covering.

The photographs showed in an interesting manner the rapid growth of the antlers in the Cervidæ, the time occupied being six months. On March 20th, 1904, these horns were in the usual course shed, the weight of the pair being 21 lbs. and length of beam $45\frac{1}{2}$ inches.

Simultaneously with the development of the horns, the photographs showed the rapid seasonal change in the coat of the animal, the winter coat beginning to fall off shortly after the

Text-fig. 24.



Antlers of Wapiti, from photographs.

horns were shed. In five weeks the process was complete and the animal was in its summer coat.

Explanation of Text-fig. 24.

- A.** Head of Stag, taken April 17th, 1903, three weeks and four days after the horns were shed. Length of horns about 5 inches. Extremely vascular and sensitive, the skin of the forehead merging into the "velvety" covering; the burr (*e*) being indistinct, the bifurcation between frontal tine (*a*) and bez tine (*b*) being just apparent.
- B.** Head of same Stag, taken May 14th, viz. three weeks and four days afterwards. Here a rapid development is seen to have taken place; the frontal tine (*a*), bez tine (*b*), and beam (*c*) being well divided, a small supernumerary point (\times) making its appearance at the base of the left horn. Horns still vascular and warm, and covered with thick epidermis or "velvet"—the burr (*e*) being more definite.
- C.** The same head, taken June 25th, five weeks and four days afterwards. Within this period the most marked development takes place; the frontal (*a*), bez (*b*), and trez (*c*) tines being fully developed, and the apex of the beam (*d*) splitting up into the characteristic three sur-royals. The velvety covering is now shrinking, and the nutrient blood-vessels can be discerned; the burr (*e*) is now quite prominent.
- On July 24th the horns, though still covered with velvet, are quite adult. During August the velvet begins to peel off, and by the first week in September the horns are usually clear.

Mr. Holding also exhibited a fine pair of antlers of the Irish Red Deer (*Cervus elaphus*) having 14 points, which had been sent to him by Sir Douglas Brooke, Bart., F.Z.S., Co. Fermanagh. They weighed 8 lbs. and were 37 inches in length.

Mr. R. I. Pocock, the Superintendent of the Gardens, exhibited living specimens of hairless varieties of the Common House-Mouse (*Mus musculus*) and Brown Rat (*M. decumanus*), and remarked that the available evidence seemed to prove that the abnormality was always correlated with a wrinkled skin. The living specimens exhibited further suggested that it was accompanied by weakness of the eyes, and in the case of the Mouse by the absence, or at all events diminution, of the smell so characteristic of that animal.

Mr. Pocock also exhibited four young examples, between five and six weeks old, of the Egyptian Fat-tailed Gerbille (*Pachyromys dupresi*), which were born in the Menagerie and reared by hand, owing to the death of the mother when the young were only six days old. One of the young had never opened its eyes and would probably be permanently blind. There were five young in the brood, but one had died. Mr. Pocock also showed a

newly-born example of this species, which was naked and blind and scarcely distinguishable from the young of the Common Rat. In this respect the young differed markedly from those of the Egyptian Spiny Mouse (*Acomys*), which were born with the eyes open and the skin covered with hair, the brood consisting of but two individuals only. This fact further supported the view that the condition of the young at birth could not be taken as a criterion of affinity in the case of the Rodentia.

The following papers were read :—

1. On some New and Little-known Butterflies, mainly from high elevations in the N.E. Himalayas. By Lt.-Col. J. MALCOLM FAWCETT *.

[Received April 9, 1904.]

(Plate IX.†)

[The complete account of the new species described in this communication appears here, but as the names and preliminary diagnoses were published in the 'Abstract,' such species are distinguished by the name being underlined.—EDITOR.]

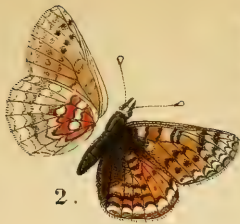
The main object of this paper is to describe some species which were taken by the native collectors of Mr. J. C. White, British Commissioner in Sikkim, at high elevations in the N.E. Himalayas, on the borders of Thibet. I have been unable to identify them with any species in the Collection of the British Museum, or in the Rothschild Collection at Tring, and they were subsequently sent to Mr. H. J. Elwes, who is unacquainted with them.

Under these circumstances it appears to me necessary that they should receive names, although future investigation may perhaps demonstrate some of them to be geographical forms of species already described. It also appears essential that the three species of *Colias* which have been taken at high elevations on the Sikkim-Thibet Frontier should be figured together; and for this reason a figure and description of *C. eogene* var. *leechi* (Gr.-Gr.), of which a figure does not appear to have been hitherto published, have been added to the figures and descriptions of the two new species.

At the same time that the above-mentioned species were taken, there were also four species of the genus *Parnassius* captured on the Sikkim-Thibet Frontier: one is clearly *P. imperator* (described by Herr Frühstorfer as *P. imperator augustus*); a second is *P. epaphus* var. *sikkimensis* Elwes; and the other two have been

* Communicated by the SECRETARY.

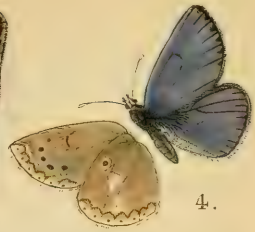
† For explanation of the Plate see p. 141.



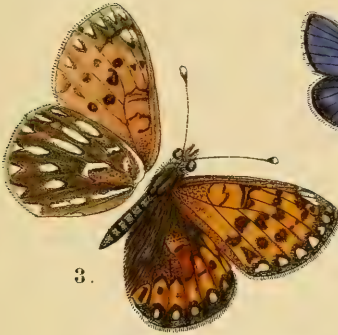
2.



1.



4.



3.



5.



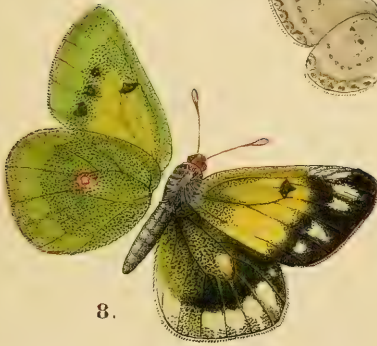
5a.



7.



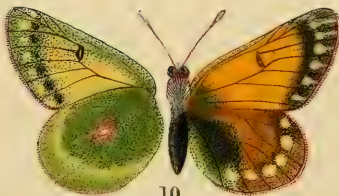
6.



8.



9.



10.



10a.

identified by Mr. Elwes as varieties of *P. acco* and *P. delphius* respectively; the two latter were described as *P. acconus* ♂ and ♀ by Herr Frühstorfer from the writer's figures.

A species of *Ragadia*, from the Battak Mts. in Sumatra, has been added to the paper, and is here figured for the first time.

Family SATYRINÆ.

1. *RAGADIA SIMPLEX* Fawcett. (Plate IX. fig. 1.)

Ragadia simplex Fawcett, Ann. & Mag. Nat. Hist. ser. 6, vol. xx. p. 111 (1897).

Expanse 1 in. 6 lin.

Habitat. Battak Mountains, Sumatra, June 1896.

DESCRIPTION.—*Male.* *Upper side* pale fuliginous brown, crossed by two darker fuscous bands running parallel to one another from the costa of the fore wing to the inner margin of the hind wing, the outer being much broadened on the hind wing. There is also a shorter band proximal to the body, which, starting parallel to the others on the fore-wing costa, ends at the origin of the submedian on the fore wing. From the apex of the fore wing to the inner angle of the hind wing runs a submarginal row of small, indistinct, fuscous spots, one in each interspace. The wing-margins are narrowly fuscous, the colour being bounded by a narrow submarginal band looped on the fore wing and on the hind wing parallel to the margin. *Under side* similar in markings to the upper, but the ground-colour pale buff and the row of spots silver instead of fuscous.

The antennæ, head, thorax, abdomen, and legs like those of *R. crisia* Hübner, from which this species differs in its generally pale ground-colour, and in the ocellate band of *crisia* being reduced to mere pupils of silver below and fuscous above.

Family NYMPHALINÆ.

2. *MELITÆA TIBETANA*. (Plate IX. fig. 2.)

Melitæa tibetana Fawcett, Abstr. P. Z. S. 1904, No. 9, p. 8, June 14.

Expanse 1 in. 2 lin.

Habitat. Khamba Jong, Thibet, 15,000 ft. elevation.

DESCRIPTION.—*Upper side*: both wings pale dull ferruginous, apex of fore wing pale ochreous; costa and base of wings and anal margin of hind wing dark fuscous. Fore wing with two black marks in cell and one at its apex; base of cell inside the first mark, and between the second and third marks, pale ochreous; two transverse series of black discal spots, the inner series highly angled outwardly above the third median nervule, enclosing between them a pale ochreous fascia; a marginal series of pale ochreous lunules inwardly defined with fuscous and

outwardly by a fuscous marginal line, and a pale ochreous lunule basally between the submedian nervule and first median nervule; cilia whitish. Hind wing with the marginal fuscous line and submarginal lunules as in fore wing; the transverse series of black discal spots and ochreous fascia as in fore wing, and two black marks in discoidal cell. *Under side*: fore wing very pale ferruginous, fading into sordid white at the apex and along the costal margin; discal markings of upper side obsolescent except near the apex. Hind wing buff, with a subbasal band, a spot in the cell, an angulated discal band, and a lunulated submarginal band all white, defined outwardly by black atoms and fine lines, the cell and subbasal band surrounded by ferruginous spots.

This species is probably a local race of the variety of *M. sindura* Moore described by Mr. H. J. Elwes in Trans. Ent. Soc. Lond. 1888, pt. iii. p. 336, pl. x. figs. 5 & 6, which = *M. sikkimensis* Moore, but differs from it in its much paler coloration, and the presence on the upper side of the pale ochreous bands and spots above mentioned, and the more prominent fuscous markings.

Five specimens from Khamba Jong in my possession present no variation from the above description. *M. sindura* var. Elwes, is an uniformly bright ferruginous insect with no pale fasciæ or spots; and I possess six specimens of it from 17,000 ft. in Native Sikkim, as also six specimens of a larger and darker form from 10,000 ft. in Sikkim interior, in which the submarginal lunules are obsolescent.

3. ARGYNNIS CLAUDIA. (Plate IX. fig. 3.)

Argynnis claudia Fawcett, Abstr. P. Z. S. 1904, No. 9, p. 8, June 14.

Expanse 1 in. 6 lin.

Habitat. Khamba Jong, Thibet, 15,000 ft. elevation.

DESCRIPTION.—*Upper side* rich fulvous (pale fulvous in some specimens), the base of fore wing narrowly and that of hind wing broadly irrorated with black atoms. Fore wing with three curved streaks in the cell, and one at its apex, thicker than the remainder; two transverse discal series of black spots, the inner one very irregular and highly angled outwardly above the third median nervule; a series of submarginal fulvous cuneiform lunules, defined inwardly by a thick black line and outwardly by a thick black band; cilia white. Hind wing with the submarginal lunules and transverse series of spots as in the fore wing, except that the outer series is reduced to four spots (2 subapical and 2 subanal) in some specimens, and to three in others, the remaining spots being obsolete. *Under side*: fore wing similar to upper side but paler, the black marks and spots smaller, and the outer transverse series of spots obsolete; apex green; marginal series of lunules silvery and two silver sutapical spots below the costa; no marginal lines. Hind wing dark green, with a slight bronzy suffusion; two basal silver spots below the costa, a linear silver

spot defining the apex of the cell and a linear one near the inner margin; the space between the two transverse discal rows of black spots (of the upper side) occupied by a series of linear silver streaks between the nervules; a submarginal series of triangular silver spots, much produced inwardly, and between these two series of silver spots and streaks a faint indication of a submarginal line of yellow spots; no marginal lines.

This species is nearly allied to *A. clara* Blanchard, but differs from it in its rounder wings, smaller size, and paler colour. On *upper side*, outer margins of both wings broadly fuscous, containing a submarginal series of pale spots, without the submarginal and marginal fine black lines beyond them as in *A. clara*; the inner transverse series of discal spots angled outwardly above 3rd median nervule on both wings, and the outer discal series of black spots is reduced, on the hind wing, to 4 and sometimes 3 spots, the spot on the lower discoidal interspace being always absent. *Under side*: the fulvous colour of fore wing is paler and redder, and the green colour of apex of fore wing and hind wing is duller and darker; bronzy suffusion less, and extends to the margin without the marginal fulvous border of *A. clara*. The only variation from the above description in five specimens from Khamba Jong is that one specimen is more melanic, while another has a paler ground-colour. The *A. clara*, var. *clarina* of Staudinger (Cat. Lep. Pal. p. 38) cannot be referred to this species, as he says nothing about his species being smaller than *A. clara*, and describes it as having the black spots smaller, whereas this species is more melanic than *A. clara*.

Family LYCÆNIDÆ.

4. LYCÆNA ARIANA Moore, var. ARENE. (Plate IX. fig. 4.)

Lycæna ariana Moore, var. *arene* Fawcett, Abstr. P.Z. S. 1904, No. 9, p. 8, June 14.

Expanse 1 in. 3 lin.

Habitat. Khamba Jong, Thibet, 15,000 ft. elevation, July.

DESCRIPTION.—*Male*. *Upper side*: both wings bright cyaneous blue, margins narrowly black, extending slightly up the nervules; cilia broadly white. *Under side*: both wings purple-grey; hind wing suffused with metallic greenish grey at base and on inner margin. Fore wing: apex of cell defined by a narrow black streak outwardly surrounded by white; a discal series of five minute black spots ringed with white, the subcostal spot evanescent; a marginal series of white spots with minute black centres, defined inwardly by obsolescent traces of orange lunules. Hind wing with the marginal white spots larger, and the orange lunules defining them inwardly more distinct, that at anal angle geminate; a subcostal black spot, and a discal series of minute black spots ringed with white, varying in number from two to three, and entirely obsolete in some specimens (this is the form

figured); a thin black streak at apex of cell, in a large cuneiform white spot, and opposite this spot another large cuneiform white spot, with its base on the centre of the line of orange submarginal lunules.

This species differs from *L. ariana* Moore from the N.W. Himalayas in being smaller, and in the discal row of black spots on the under side being minute, fewer in number, and obsolete, in some specimens, in the hind wing; and in the discal white spots at the apex of cell of hind wing being larger.

5. *LYCÆNA PHERETES* Hübner, var. PHARIS. (Plate IX. figs. 5 ♂, 5 ♀.)

Lycæna pheretæ Hübner, var. *pharis* Fawcett, Abstr. P. Z. S. 1904, No. 9, p. 8, June 14.

Expanse 1 in.

Habitat. Khamba Jong, Thibet, 15,000 ft. elevation, July.

DESCRIPTION.—*Male*. *Upper side* dark purple-blue; fore wing with a black marginal line; margin of hind wing more broadly black, especially at apex and costa; cilia broadly white. *Under side*: fore wing purple-grey, paling towards apex; a black spot ringed with white at apex of cell; a discal series of small black spots ringed with white, varying in number; in some specimens only three, usually four. Hind wing pale brownish on the disk, fading into pale greenish-ochreous at the margin, with the following pale ochreous spots: one in and extending beyond discoidal cell, cuneiform; a discal series of six beyond it, and an indistinct one basally below the costa.

Female. *Upper side* dark fuscous, basally irrorated with blue; *under side* as in male.

This form differs from the var. *asiatica* of Elwes in having fewer discal black spots on fore wing, and in the size and length of the pale cellular spot on hind wing.

6. *LYCÆNA (ZIZERA) ZERA*. (Plate IX. fig. 6.)

Lycæna (Zizera) zera Fawcett, Abstr. P. Z. S. 1904, No. 9, p. 9, June 14.

Expanse 1 in. 11 lin.

Habitat. Tounghoo, Burma, June.

DESCRIPTION.—*Male*. *Upper side* shining violet; fore wing with a pale spot at the apex of the discoidal cell; a broad fuscous marginal band extending slightly up the nervules, but the inner border regular and bending inwards on the costa. Hind wing with the marginal fuscous band broad at the apex, narrowing to a black marginal line, inside which are placed five fuscous lunules; cilia broadly white. *Under side* pale grey: fore wing with a fuscous streak, ringed with white, defining apex of cell; a discal row of six fuscous spots ringed with white; a row of marginal spots faintly defined inwardly by fuscous lunules. Hind wing: discal row and a marginal series of fuscous spots as in fore wing;

three subbasal black spots ringed with white, the centre spot inside the cell.

This species is nearly allied to *Z. marginata* from China, but differs in the discal row of fuscous spots of the fore wing being fainter and more regular on the under side, and the black border of the upper side being more even in its inner edge and bending inwards on the costa.

7. LYCÆNA (NIPHANDA) MARCIA. (Plate IX. fig. 7.)

Lycæna (Niphandia) marcia Fawcett, Abstr. P.Z.S. 1904, No. 9, p. 9, June 14.

Expanse 1 in. 2 lin.

Habitat. Tounghoo, Burma, June.

DESCRIPTION.—*Male.* *Upper side* shining violet, with the spots of the underside showing up indistinctly. Fore wing with a narrow fuscous band on the costa and outer margin; hind wing: costa, apex, and abdominal margin broadly fuscous, and a row of fuscous lunules on the outer margin; cilia white between the ends of the nervules. *Under side* pale violaceous grey, with the following brown marks ringed with white:—fore wing with a short basal streak below the costal nervure; two spots, one above the other, and the lower one the larger, in centre of cell, and below the lower spot a large triangular space between the first median nervule and the submedian nervure; a spot defining the end of the cell; a discal fascia of seven spots, interrupted in the middle, and with the outer edge of the upper four spots defined outwardly by fuscous; a pale and indistinct submarginal and marginal lunular fascia, the lunules of which are largest and most defined between the median nervules. Hind wing with a blackish-brown spot at base of cell, two black spots below costal margin, and a similar spot below the outer one; an irregular row of pale discal spots, and a marginal row of white lunules, the first three and the sixth from the anal angle with black centres.

This species is probably a local race of *L. (Niphandia) tessellata* Moore, from Penang, but differs from it in its much less heavy markings on the under side. There is also a specimen (at present unnamed) in the British Museum which agrees with the specimen here described.

Family PIERINÆ.

8. COLIAS BERYLLA. (Plate IX. fig. 8.)

Colias berylla Fawcett, Abstr. P.Z.S. 1904, No. 9, p. 9, June 14.

Expanse 2 in. 9 lin.

Habitat. Khamba Jong, Thibet, 15,000 ft. elevation.

DESCRIPTION.—*Female.* *Upper side*: fore wing pale lemon-yellow, base and costal margin broadly irrorated with black atoms; a diamond-shaped black spot at apex of cell; hind or

outer margin broadly black, irregularly dentate on nervules on its inner edge, with the following sulphur-yellow spots, viz., five forming a curved row near the apex from costa to 3rd median nervule, the lower two being larger than the upper three; also one spot between the 1st and 2nd median nervules, and one between the 1st median nervule and the submedian nervure; cilia of both wings whitish with a pink suffusion. Hind wing black, basally thickly irrorated with sulphur atoms; an orange spot at end of cell; anal and outer margin sulphur-yellow, which forms into a line of lunular spots on outer margin. Body black, head and antennæ pink. *Under side*: fore wing—disk pale yellow; apex and outer margin grass-green, with a submarginal line of pale yellow spots; a black spot at apex of cell, and three black discal spots in a row between the median nervules and submedian nervure. Hind wing grass-green, paler on outer margin, and irrorated with black atoms; a silver spot surrounded by a pink area at the apex of the cell.

This species belongs to the *hyale* section of the genus *Colias*, and is nearest to *C. erschoffi* Alphéraky, from the Tian Shan Mts.

9. COLIAS NINA. (Plate IX. fig. 9.)

Colias nina Fawcett, Abstr. P. Z. S. 1904, no. 9, p. 9, June 14.

Expanse 2 in. 9 lin.

Habitat. Khamba Jong, Thibet, 15,000 ft. elevation.

DESCRIPTION.—*Female*. *Upper side*: fore wing pale sulphur-yellow, the disc below the median nervure and 3rd median nervule orange; a black diamond-shaped spot at apex of cell; a broad black outer marginal band, inwardly irregularly dentate on the nervules, irrorated with sulphur-yellow scales outwardly, and a submarginal row of ill-defined sulphur spots between the nervules, that between the 2nd and 3rd median nervules being obsolete. Hind wing black, irrorated with pale sulphur atoms, most thickly towards the base and outer margin; discoidal cell pale yellow, with an orange spot at its apex; a submarginal row of pale sulphur hastate spots; antennæ and cilia pinkish. *Under side*: fore wing—disk as on upper side; apex and outer margin pale green, irrorated with black atoms; a black spot at apex of cell, and three or four ill-defined black spots discally between the nervules. Hind wing pale green, with spots as on upper side.

This species appears to be a transition between the *hyale* and *edusa* sections of *Colias*.

10. COLIAS EUGENE Felder, var. LEECHI Gr.-Gr. (Plate IX. figs. 10 ♂, 10 ♀.)

C. eogene Felder, Reise Novara, p. 196, t. 27. f. 7, ♂ (1865).

Var. *leechi* Grum-Grshinnailo, Horæ Soc. Ent. Ross. xxvi. p. 382 (1893).

Expanse 1 in. 4 lin.

Habitat. Native Sikkim, 19,000 ft., July.

DESCRIPTION.—*Male*. *Upper side* orange, base narrowly irrorated with black atoms; a black diamond-shaped spot at apex of cell; a fuscous marginal band, with a row of pale yellow hastate spots between the nervules. *Hind wing* orange; inner margin green, irrorated with black atoms; a paler spot in cell, and a submarginal row of pale yellow hastate spots; apex and outer margin fuscous. *Under side*: fore wing—disk paler than upper side; apex and costa grass-green, irrorated with black atoms; a black spot at apex of cell, and a submarginal row of black spots, ill-defined towards the apex, and beyond them a row of pale yellow spots. *Hind wing* grass-green; a pale sulphur submarginal fascia, irrorated with dark green atoms; a silver spot in a reddish area at end of cell. Head, antennæ, and cilia pink.

Female. *Upper side*: fore wing orange, paling on the costa to yellow; base and median nervules irrorated with black atoms; marginal band and spots as in male. *Hind wing* black; cell yellow, with an orange spot at its apex; a marginal band of sordid-sulphur lunulate spots. Head, antennæ, and cilia as in male.

The specimens in my possession have been identified by Mr. H. J. Elwes as var. *leechi*. Herr Frühstorfer erroneously described two of my figures as representing a new species, under the name of *C. eogene*, subsp. *miranda* (Insekten Börse, xx. 19. 148, May 1903). These figures are introduced into this paper because this variety does not appear to have been figured previously, and with a view to complete the series of forms of *Colias* from the borders of Sikkim and Thibet.

Since these notes were written I have seen a paper published by Mr. H. J. Elwes in 'Iris,' 1904 (pp. 388 *et seqq.*), on the subject of the descriptions and figures above referred to. In this paper Mr. Elwes refers to this species of *Colias* as "*stoliczkana*," although he had previously written "*leechi*" below the figures I submitted to him for identification. The male of this species, however, differs from the figure of the male of *C. stoliczkana* in the British Museum. The var. *stoliczkana* has hitherto been recorded only from Ladak, Fergana, and Amdo; while the var. *leechi* has been recorded only from China.

EXPLANATION OF PLATE IX.

- Fig. 1. *Ragadia simplex* Fawcett, p. 135.
2. *Melitæa tibetana* Fawcett, p. 135.
3. *Argynnis claudia* Fawcett, p. 136.
4. *Lycæna ariana* Moore, var. *arene* Fawcett, p. 137.
5. *Lycæna pheretes* Hübner, var. *pharis* Fawcett, ♂, p. 138.
- 5 a. Ditto, ♀.
6. *Lycæna* (*Zizera*) *zera* Fawcett, p. 138.
7. *Lycæna* (*Niphanda*) *marcia* Fawcett, p. 139.
8. *Colias berylla* Fawcett, p. 139.
9. *Colias nina* Fawcett, p. 140.
10. *Colias eogene* Felder, var. *leechi* Gr.-Gr., ♂, p. 140.
- 10 a. Ditto, ♀.

2. On Seasonal Phases in Butterflies.

By A. G. BUTLER, Ph.D., F.L.S., F.Z.S., &c.

[Received May 10, 1904.]

The fact that Butterflies emerged from the pupa in markedly different forms at different times of the year was made evident many years since by the labours of W. H. Edwards in the United States, by Mansel Weale in South Africa, and by Doherty and de Nicéville in India; but this fact was misunderstood, and therefore not fully accepted by many workers for years afterwards, whilst not a few are sceptical as to its truth at the present day.

One of the chief reasons for this scepticism is based upon the unquestionable truth that the dry-season type of a species not unfrequently emerges in the wet season and *vice versa*. That I was myself rendered sceptical for years on this ground will be seen by referring to some of my earlier papers in which the question of seasonal forms had to be considered.

In a paper published in 1884 (P. Z. S. pp. 478-501) I recorded the remarkable fact that, at Aden, *Limnas chrysippus*, *Hypolimnas misippus*, and *Catopsilia florella* produced all their varietal phases simultaneously, and that *Teracolus "nouna" = saxeus* (which actually is the *T. evagore* of Klug) occurred in March, April, and May, whilst *T. yerburii* was also obtained commonly in April and May; but I did not then fully appreciate the fact that all these were instances of the simultaneous emergence of phases characteristic of seasons and climates, and that they represented the probable condition of all very variable types before seasonal or climatic changes had begun to act upon them.

As with protective mimicry, the more enthusiastic exponents of which have frequently erred in supposing that because this was of use against one enemy, it must necessarily be against all; so has it been with those who desired to believe in, but failed to comprehend, seasonal variation. That I misunderstood it myself in 1886 is clear from the remarks which I made in a paper upon Lepidoptera from Western India (P. Z. S. p. 399) respecting the broods of *Belenois mesentina*: in 1888 I was no wiser, as my remarks emphasising the importance of dates of capture in the case of certain species of *Teracolus* clearly show (Ann. & Mag. Nat. Hist. ser. 6, vol. i. p. 201).

In 1895 (P. Z. S. p. 727) I hinted at the possibility of *Hypanartia schœneia* and *H. hippomene* being seasonal forms of the same species, and in 1896 (P. Z. S. p. 112) I considered this probable; yet later in that year (P. Z. S. p. 285) I concluded that this was an error, because both were captured on the same mountain upon two successive days. At this date, therefore, it is quite evident that I considered it impossible for wet and dry phases of any species to occur simultaneously. Indeed, it was only after reflecting upon the probable identity of *T. yerburii* with the supposed *T. nouna* (P. Z. S. 1896, p. 247) that I began

to have some idea that because a type of pattern and coloration was characteristic of a particular season or climate, it did not necessarily exclude other types: therefore that it was not impossible for phases characteristic both of dry and wet seasons or climates to be sometimes found flying together; that in a very dry country like Aden it was the rule rather than the exception for wet, intermediate, and dry phases of a species to occur commonly together in each brood.

That this polymorphic character was probably of earlier date than the more or less defined seasonal phases, of such countries as exhibit great variations of weather at different seasons, seemed evident to me from the fact that in very moist countries the extreme dry phase of species is exceedingly rare, and probably near to extinction. In *Precis sesamus*, the dry phase of *P. natalensis* (= *calescens*) from Southern and Eastern Africa, the seasonal phases are very distinct, but about equally abundant. In the wet season, as pointed out by me (P. Z. S. 1898, p. 904), both forms may be taken flying together in Mashunaland; and on that ground I proposed that the term "seasonal form" should be rejected, and the term "seasonal phase" substituted*. On the West Coast *P. calescens* or *natalensis* is represented by *P. octavia* of Cramer and a number of intermediate phases, but no extreme dry phase was recorded until 1901, when, in my "Revision of the Butterflies of the genus *Precis*" (Ann. & Mag. Nat. Hist. ser. 7, vol. viii. p. 205), I mentioned an imperfect example indistinguishable from typical *P. sesamus* as having been received from Onitsha on the Niger. The extreme rarity of this phase on the West Coast, and the probability that it has become absolutely extinct at Sierra Leone, seem to indicate that it is unsuited to the conditions of a moist climate; whilst the numerous intergrades from the dry to the wet phase on the same coast certainly indicate the transition from fixed varieties, such as obtain where seasons are well defined, towards a more or less wet type. In Southern and Eastern Africa intergrades between *P. sesamus* and *P. natalensis* are extremely rare, the most striking of such intergrades being figured by me in 1900 (P. Z. S. pl. lviii. fig. 1).

As it is by no means rare for individuals of the wet phase of a species to emerge from the pupa in the dry season, there is no reason why Lepidopterists should be startled when this occurs. They should bear in mind the probability of the fact that, as all the phases of some species occur as simple varieties in extremely dry countries, they also formerly existed as varieties in other species; that the latter, as they gradually extended their range, were subjected to widely different conditions; that then the summer phase (as we now understand it) was so conspicuous in the winter, and the winter phase so conspicuous in the summer, that their chance of survival at the unsuitable season was lessened; and thus it came about in course of time that one variety of the species became the prevalent wet phase, and

* See also P. Z. S. 1900, p. 916.

another the prevalent dry phase. But it is absurd to assume that the evolution of these seasonal phases is already perfect and complete over the whole globe, and to speak of the occurrence of wet and dry phases at any season as "very remarkable"; as a matter of fact, it would be more remarkable if they never did occur simultaneously.

3. The Prey of the Lion.

By Capt. RICHARD CRAWSHAY, F.Z.S.

[Received June 3, 1904.]

Prevailing opinion is so often at variance with my own experience on the question of the prey of the Lion, that I venture to offer a few remarks on those experiences covering a period of many years' travel and residence in Central Africa. It is generally believed that the Lion is a fastidious feeder, eating only what he has himself killed in the shape of the larger mammals. I have not found the Lion by any means particular in confining himself to his own kills, or in disposing of carrion when in tolerably good condition.

As to his prey being only the larger mammals, this is not invariably the case, for I am able to establish one instance at least of his preying on the Porcupine. Mr. Selous has it on record that a Lion has eaten the skin of a Sable Antelope preserved with arsenical soap as a natural history specimen. Nothing as remarkable as this has occurred within my own knowledge, but I have known a great many instances of Lions feeding on carrion of my own killing, such as the carcasses of Elephants on several occasions.

The main purpose of my note is to exhibit two Porcupine-quills taken from the left fore-paw of a Lion—the skull, skin, and claws of which I also exhibit. This Lion was shot by myself two days' journey N.W. of Kibwezi, East Africa Protectorate, in March 1898. *Three* quills were found in the paw, one of which I regret has since been lost. The *two* exhibited measure each approximately 1 inch in length. The cartilage in which the quills were embedded showed no inflammation, so it can be inferred that these at first most painful inflictions must have been there for a considerable time.

There is no reason for supposing this Lion killed the Porcupine under the impulse of hunger, because the country *teemed* with game of all kinds—from rhinoceros, zebra, and ostriches, to vast numbers of antelope, large and small.

My Ahenga, when I questioned them as to whether they knew other instances of Lions preying on such small game as Porcupines, seemed amused, and replied:—"Oh, indeed! even field rats: they tear them out of the ground with their claws!"

The larger mammals, no doubt, form the Lion's chief prey—Buffalo more especially, when these abounded; but, as can be seen, there are times when even small rodents are in requisition.

4. Note on an apparently Abnormal Position of the "Brephos" within the Body of a Skink (*Chalcides lineatus*). By FRANK E. BEDDARD, M.A., F.R.S.,
Prosector to the Society.

[Received May 11, 1904.]

(Text-figure 25.)

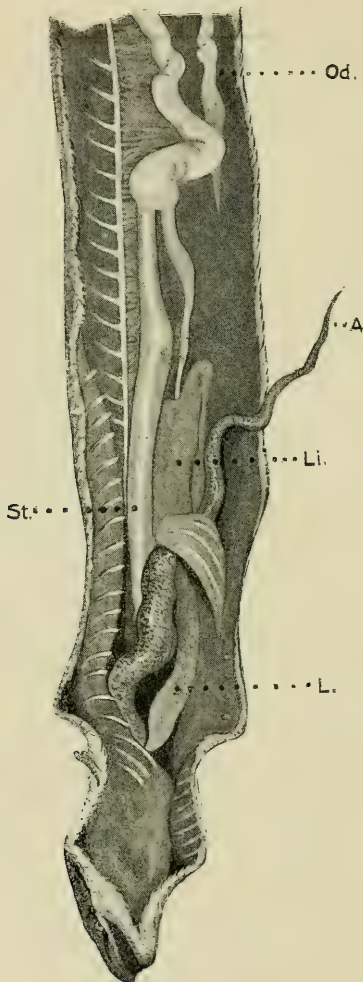
Among a number of examples of the Lizard *Chalcides lineatus* which arrived in the Society's Menagerie on May 3rd, one was found to be dead on its arrival. On opening the Lizard, which proved to be a gravid female, a possible cause of death was at once obvious. The reptile presented a case of what may be called extra-uterine pregnancy, and may have been unable to get rid of the two young ones. That is, at any rate, one way—and perhaps the most probable way—of interpreting the following facts.

The Lizard itself measured 12 inches in length, including the tail, and the young ones were of the same size, and measured within a very few millimetres of $3\frac{1}{2}$ inches*. I did not attempt a more exact measurement, as they were somewhat twisted. The yolk-sac was not fully absorbed, and formed a string-like appendix of about $\frac{1}{4}$ inch in length. In other respects these fetuses were exactly like the parent and obviously, at the very least, ready to be born. *Neither brephos was within the oviduct. Both lay, in fact, apparently in the body-cavity.* The position of one of them is shown in the accompanying drawing (text-fig. 25, p. 146), which was made before the relations of surrounding organs were much disturbed. Its head lies not far from the head of the parent; the end of the tail is nearly on a level with the posterior extremity of the liver. The second brephos lay much further back, but I cannot give exact details, as it was liberated on cutting open the body-wall of the parent. Both young ones lay in a slight spiral curve like the popular representations of a snake. There are some other facts of interest in connection with the abnormal situation of the two young *Chalcides*. The ovaries contained numerous round white eggs, the largest of which did not measure more than 2 mm. in diameter. I presume, therefore, that they are not nearly ready for fertilisation. The two oviducts were in a condition corresponding to that of the two ovaries. They showed no signs whatever of having recently contained eggs or embryos. Nor, on the other hand, was there anything in the least abnormal about them or their drawn-out peritoneal orifices. They were quite uninjured by my dissections. It seems to me, therefore, to be indisputable that at least a great part of the development of the two embryos must have taken place outside of the oviduct or oviducts. And it is remarkable that this took so long in producing an injury grave enough to be fatal to the mother. Indeed, there were no signs whatever of pathological conditions

* The Scincidae are, at least for the most part, ovoviviparous.

in the organs neighbouring upon the two young ones; and one is thereby tempted to speculate as to how far this—as would be supposed by most—abnormal state of affairs is really abnormal. Such cases of extra oviducal fetation may be in part responsible

Text-fig. 25.

Dissection of *Chalcides lineatus*.

A, brephos; *L.*, lung; *Li.*, liver; *St.*, stomach; *Od.*, oviduct.

for some of the legends concerning the swallowing of their young by various reptiles for protection's sake. In the present instance, for example, as may be seen from the drawing exhibited, an unskilled observer opening the body of the parent and seeing the

head of the brephos lying apparently within the gullet, and at any rate anteriorly in the body, might arrive at a conclusion opposed to the real facts which more accurate observation reveals. One rather important piece of evidence is commonly omitted in those cases of alleged swallowing of the young, which I refer to here for other reasons, and only incidentally as concerned with popular beliefs. Each brephos has not only the small white vesicle adherent to the body already referred to, but considerable vestiges of the other embryonic sacs invest and are attached to it. These are distinguishable by their grey colour, and are comparatively bulky. In the case of one brephos, they are attached to it; in the case of the other, the young one came away from the membranes, which were found to be attached to the mesenteries, and possibly in process of being absorbed. Any suggestion of protection by the mother within her body of actually born young would of course be negated by these facts.

5. Contributions to the Knowledge of the Visceral Anatomy of the Pelagic Serpents *Hydrus platyurus* and *Platyurus colubrinus*. By FRANK E. BEDDARD, M.A., F.R.S.,
Prosecutor to the Society.

[Received May 20, 1904.]

(Text-figures 26-28.)

In the comprehensive works of Milne-Edwards* and Meckel† and others, there are numerous references to various points in the anatomy of the pelagic Ophidia, while a more particular account of the viscera of one species has been given by Cantor‡. The lungs have been particularly dealt with, though very briefly, by Cope§; while Mr. G. W. Butler|| has incorporated remarks upon some of these snakes into his general papers upon the asymmetry of the Ophidian lung. Both the last-mentioned papers contain references to previous literature.

I have had the opportunity of dissecting one example each of the marine snakes *Hydrus platyurus* and *Platyurus colubrinus* which have been in my possession for some time, the latter specimen belonging to me, the former to the Prosecutor's Stores. This dissection enables me to add something to our knowledge of the anatomy of the Hydrophiinæ, and to compare two quite distinct generic types. I had not expected to find them so different as dissection showed them to be.

(1) *Platyurus colubrinus*.

The specimen of this snake which I dissected measured in all nearly 17 inches, of which a little over two belong to the tail.

* 'Leçons sur la Physiologie et l'Anatomie comparée.'

† 'Anatomie comparée.' French Transl.

‡ "Observations upon Pelagic Serpents," Trans. Zool. Soc. ii. p. 303.

§ "On the Lungs of the Ophidia," Proc. Am. Phil. Soc. xxxiii. 1894, p. 217.

|| In P. Z. S. 1892, p. 477, and P. Z. S. 1896, p. 691.

The location of the different organs of the body and the lengths of some of them in relation to the total length of the body differ in this serpent from the corresponding situation and measurements of *Hydrus platyurus*, which are placed side by side for the purposes of easier comparison.

	<i>P. colubrinus.</i>	<i>H. platyurus.</i>
Length of body to vent	14 inches.	23 inches.
From tip of snout to base of heart	5½ inches.	5 inches.
From tip of snout to anterior end of liver	5½ inches.	6 inches.
From apex of heart to anterior end of liver	½ inch.	⅛ inch.
Length of liver	3⅝ inches.	3 inches.
Posterior end of liver to gall-bladder	¾ inch.	1½ inches.
Posterior end of liver to anterior end of kidneys ...	1⅞ (R), 2¼ (L).	7½ (L), 7 (R).
Length of kidneys	½ inch, ½ inch.	2¾, 2¾.
Posterior end of kidneys to vent	1¼ (R), ¾ (L).	3¼ (R), 2½ (L).

It is plain from these measurements that the *situs viscerum* shows important differences in the representatives of the two Hydrophiine genera. In *Hydrus* the heart is placed much further forward, *i. e.* the neck is shorter than in *Platyurus*, and the kidneys of the latter are relatively further from the posterior end of the body. In both, the anterior end of the liver lies close behind the heart, as is the case in Viperine serpents, a fact also noted by Cantor in the species dissected by him.

Alimentary viscera.—The liver is long and thin, and thus characteristically Ophidian. It is very long compared with that of *Hydrus*, measuring as it does about one-fifth of the total body-length (including the tail), or nearly one-fourth if the tail be omitted. Taking the length of the body (to the vent) as 100 in all cases, the following are the proportions of the liver in a number of serpents.

Zamenis flagelliformis, 19⅓.

„ *gemonensis*, 20⅔.

Coronella getula, 23⅔.

Coluber melanoleucus, 18⅞.

Tarbophis obtusus, 21¼.

Naia tripudians, 21¼.

Ophiophagus bungarus, 24⅔.

Platyurus corallinus, 21⅓.

Hydrus platyurus, 14¼.

Python spilotes, 15¼.

Eryx jaculus, 22¼.

„ *conicus*, 21¾.

Heterodon platyrhinus, 22¼.

Boa constrictor, 17⅓.

Causus rhombeatus, 23¼.

Lioheterodon madagascariensis, 20½.

The liver shows a peculiarity not without interest, which has been also figured and referred to by Dr. Cantor* in the Sea-Snake dissected by him. In *Platyurus*, however, this character—the

* *Loc. cit.*

division of the liver by furrows running at right angles to the longitudinal axis of the body—is more marked. I counted five of these transverse furrows, which vary in depth and divide the liver into a series of segments of hepatic substance. As I shall point out later (see p. 151), *Hydrus platyurus* shows the same "segmentation" of the liver. Milne-Edwards observes* of the liver of *Typhlops* that it is "divisé en lobes plats," and this lobation is figured also by Cope †; but it does not appear to be by any means so regular as in *Platyurus*. One cannot but put down this marked lobation to the regular bending of the body in swimming, and it forms an example of "segmentation" probably traceable to a definite mechanical cause.

The gall-bladder gives off a single duct which soon forms a very complicated network in connection with the hepatic duct. This network is very much more complex than in *Hydrus*, and the *rete* of ducts is so long before it enters the duodenum that the gall-bladder can be dissected out and pulled much further away from the alimentary canal than is possible in *Hydrus*. The pancreas seems to me to be smaller proportionately (it certainly is so actually) than in *Hydrus*. The coiled region of the intestine is very long. When the coils are left undisturbed within their coelomic space, they measure $\frac{7}{8}$ of an inch, but when unwrapped no less than 5 inches. The kidneys are approximately equal in size, each measuring about $\frac{1}{2}$ inch in length. They are broad in proportion to their length, and almost suggest those of the Boid *Eryx*. The right, anterior, kidney hardly at all overlaps the left, which commences where it ends.

§ Lung.

It has been pointed out by several zoologists, including Cope ‡, that *Platyurus* and some other genera of Sea-Serpents possess the tracheal lung found also in a few genera of terrestrial Colubrids. Cope's statement on the matter is as follows:—"Finally the tracheal lung, as I shall call it, is distinct from the true lung in *Platyurus* and in *Chersydrus*. In the former of these genera, the trachea is not separate from the lumen." I do not think, however, that any detailed description of the lung exists. I shall endeavour therefore to supply this omission by the following description. There is no trace that I could discover of a second lung. The single lung extends to within one inch of the cloacal aperture and ends abruptly without any special diminution of calibre. It lies, posteriorly at any rate, on the right-hand side and is firmly bound to the dorsal parietes.

The tracheal lung is, as Cope says, distinct from the bronchial lung; the two are separated at the end of the one and the beginning of the other by one of the pulmonary vessels which passes between them. The tracheal lung begins very high up in the body, close behind the head; it ends posteriorly just in front of the origin from the heart of the right aortic arch.

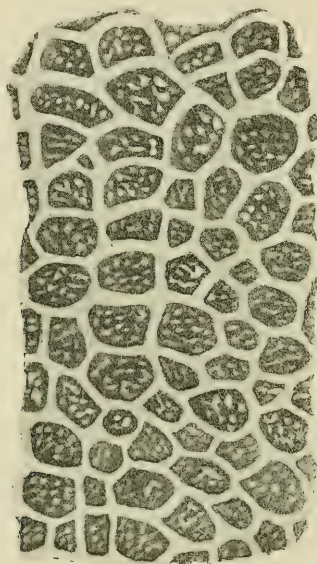
* 'Leçons sur la Physiologie et l'Anatomie comparée.'

† "On the Lungs of the Ophidia," Proc. Amer. Phil. Soc. xxxiii. 1894.

‡ *Loc. cit.* p. 217.

Until very near its posterior end the trachea forms merely a gutter along its ventral side, that is it opens freely into it throughout. Posteriorly, however, there is a distinct tendency for the lung to be connected only at intervals with the trachea, a hint—as it appears to me—of the commencing independence of the two parts of the pulmonary apparatus. The thoracic lung is very plainly a respiratory organ down to about the middle of the liver and to a less extent posteriorly. Its texture is like that of many other serpents, but not like that of *Hydruus* (see p. 153). It presents, as is shown in the accompanying drawing (text-fig. 26),

Text-fig. 26.

A portion of the internal surface of the lung of *Platyurus colubrinus*.

a honeycombed and perfectly regular structure. The depressions are naturally hexagonal through mutual pressure. I could find no difference in the structure of tracheal and bronchial lungs. The bronchus is traceable for a long way down the liver. At a little distance behind the posterior end of the liver (about $\frac{3}{4}$ of an inch), the lung, which has gradually become very narrow, widens out into a thin-walled dilatation of quite twice its former width. This dilatation is $\frac{3}{8}$ of an inch long and fusiform in shape. It is thin-walled, and thus contrasts with adjacent regions of the lung; but on its inner surface a honeycomb pattern is visible, the depressions, however, being very slightly marked. Behind this dilatation the honeycomb structure was also plainly visible. The greater part of the lung in fact seems to be utilised as a respiratory organ.

It is particularly noteworthy that the posterior region of the

lung in this serpent has not the excessively thin-walled character that it has in most land-snakes. In the latter, when dissected, the anangious region of the lung seems to be little more than a space between the viscera of the posterior region of the body. In *Platyurus* the lung has thick walls throughout. Examined in transverse sections, the posterior region of the lung, some way after the dilatation, is seen to be undoubtedly a functional lung, inasmuch as the blood-capillaries are numerous and approach very near to the inner surface, being in fact only separated from it by the pulmonary epithelium. The muscular walls are very thick, especially the inner layer of circular fibres. Evidently, therefore, the lung is capable of considerable alterations in size.

Dr. Cantor gives an account of the lungs of *Hydrophis schistosa** Schlegel (= *Enhydrina valakadien* of Mr. Boulenger's Catalogue), somewhat different from the facts as observed by myself in *Platyurus colubrinus*; these differences may be doubtless put down to the circumstance that the two serpents are of different genera. In the first place, the tracheal lung would seem to be continuous with the bronchial lung, though this is not absolutely clear from Cantor's figure†. The tracheal lung is, moreover, of much less extent in *Enhydrina*. The pattern of the meshwork is quite different. Finally the dilatation along the course of the pulmonic portion of the bronchial lung, such as I have found in *Platyurus*, is less than in *Enhydrina*, and the extreme tip of the lung in the serpent dissected by me is not tied down to the parietes by any tag. The dilatation which he does figure is apparently part of the functional lung.

(2) *Hydrus platyurus*.

Of this snake the example at my disposal was a female with the ova immature. The position of the viscera has been already dealt with in considering *Platyurus* and a comparison of the two snakes there instituted.

Alimentary viscera.—The gall-bladder, pancreas, and spleen are not unlike those of the Sea-Snake figured by Dr. Cantor‡. After receiving the hepatic duct, the bile-duct plunges into the substance of the pancreas on its way to reach the duodenum. Whether it forms a *rete* therein or not, I have not ascertained; but it is clear that there is not room for a very extensive one. The pancreas is much lobulated, and extends in front of, and behind, the gall-bladder. The liver, as will be gathered from the measurements on p. 148, is actually, as well as relatively, shorter than that of *Platyurus colubrinus*. It is, however, of a more massive structure and is less divided by transverse furrows into "segments." I detected only four of these. The liver also appears to me to be a little closer to the heart than it is in *Platyurus*. The coiled region of the intestine is relatively rather shorter than in *Platyurus*.

Kidneys.—The kidneys of *Hydrus platyurus* differ markedly from those of *Platyurus colubrinus*. They are in the first place

* "Observations upon Pelagic Serpents," Trans. Zool. Soc. ii. p. 305.

† *Loc. cit.* pl. 57. fig. 1 m.

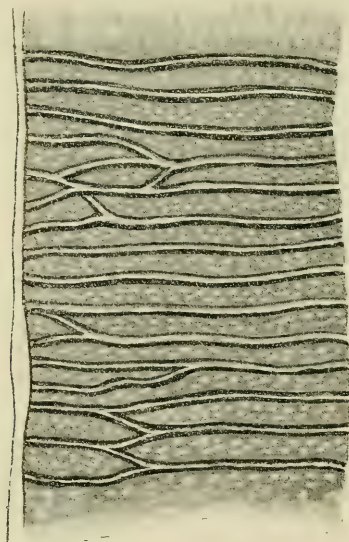
‡ *Loc. cit.* pl. 57. figs. 1, 2.

very long and thin, measuring, as has been mentioned, $2\frac{3}{4}$ inches each. While, therefore, the body of *Platyurus* is rather more than half the length of that of *Hydrus*, the kidneys of the latter are five times the length of those of the former genus. They do not, however, seem to me to be much, if any, greater in bulk, since they are extremely thin and narrow, while those of *Platyurus* are wider in proportion to their length. Another difference shown by the kidneys of the two genera is the extent to which they overlap. In *Platyurus* the two kidneys hardly overlap at all, whereas in *Hydrus* the right anterior kidney extends alongside of the first two inches of the left kidney. There is thus a considerable approximation here towards symmetrical kidneys.

§ *Lung.*

The lung-tissue is recognisable from two and a quarter inches behind the tip of the snout. It begins, therefore, very early in the neck. The lung-tissue begins gradually between the dorsal

Text-fig. 27.



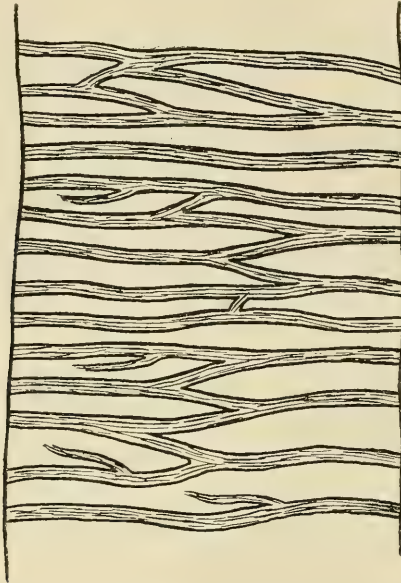
A portion of the internal surface of the lung of *Hydrus platyurus*.

non-fused ends of the tracheal rings. This snake has therefore, as has been stated, a tracheal lung. The trachea, moreover, is open throughout into the lung, and forms in fact only a gutter along its ventral surface. The neck of this serpent is short, and therefore the tracheal lung is not of great extent; it appears to cease about half an inch in front of the heart, and therefore has not a course of more than two inches. A sudden widening at that point I take to be the commencement of the bronchial lung. There is no other differentiation that I can detect. The inner

surface of the lung is marked by conspicuous thickenings; but these do not form a honeycomb network as in *Platyurus*.

The folds run across the lung—that is at right angles to its longitudinal axis, and are wavy in outline, which of course allows of expansion during inspiration (text-fig. 27, p. 152). The trachea (or bronchus) is continued as a gutter down the lung as far as the commencement of the liver, that is for a very short distance behind

Text-fig. 28.



A portion of the internal surface of the non-vascular part of the lung of
Hydrus platyurus.

the heart. The lung itself is extraordinarily long; it is indeed co-extensive with the body-cavity, reaching as far back as the vent. Its calibre too is very considerable, and its walls have the tough, almost shiny, appearance of a fish's swim-bladder. The dorsal wall is firmly fixed to the parietes. The latter part of the lung, *i. e.* after the end of that region which is respiratory, has undergone some modification in relation to its undoubted function as a swim-bladder. The folds already spoken of in the vascular region of the lung persist; but their object is no longer that of merely increasing the respiratory surface, and thus the efficiency of the lung as a breathing organ. They exist only as bands of muscular fibre, which, since their direction is mainly circular and parallel to each other, must act as constrictors and expel air from the swim-bladder part of the lung. On a naked-eye inspection of this portion of the lung, it looks almost as if the bands in question were the bronchial rings which had in this region taken on a new development. They are, however, serially continuous not

with the dwindling bronchial rings, but with the vascular folds already spoken of. Microscopical examination shows them to be thick bands of muscular fibres, which are not striated. The direction of these bands is circular, but they occasionally send off anastomosing branches as is shown in the accompanying sketch (text-fig. 28, p. 153). Occasionally, too, a small band detaches itself from one of the main hoops and ends upon the wall of the lung. Between the various bands the wall of the lung does not appear to be muscular. Towards the posterior end of the lung this arrangement is lost; there are no longer separate hoops of muscle but the walls are covered with a single sheet of musculature.

It is clear from the above description, which may be compared with that of *Platyurus* on p. 150, that the structure of the lung differs very considerably in the two species. In *Platyurus* the lung has retained to a much greater extent its pulmonary function, the lung-substance extending much further back than in *Hydrus*. The lung has, however, a less calibre, even proportionately, than in *Hydrus*, and there is no trace of so marked a conversion into a "swim-bladder" with special muscles effecting its contraction and expansion as occurs in *Hydrus*. In the latter genus, moreover, the whole lung extends further back in the body than it does in *Platyurus*.

6. On the Presence of a Parasternum in the Lacertilian Genus *Tiliqua*, and on the Poststernal Ribs in that Genus. By FRANK E. BEDDARD, M.A., F.R.S., Professor to the Society.

[Received June 3, 1904.]

(Text-figures 29 & 30.)

The use of the term "abdominal ribs" for the ventral and superficially placed cartilages, fibrous bands, or ossifications so distinctive of certain groups of Reptiles, is open to the objection that the term "ribs" has already a definite meaning attached to it. It implies cartilaginous, fibrous, or ossified rods which have or have had a connection with the vertebral column, whereas the so-called abdominal ribs have no relation whatever to the vertebral column, but are purely ventral structures formed between the plates of the ventral abdominal musculature. Furthermore, the term "abdominal ribs" is actually in use as descriptive of structures which are real ribs, and which have nothing to do with what other authors have called abdominal ribs. For example, Mr. Boulenger, in his 'Catalogue of Lizards,' has referred, under the name of abdominal ribs, to the ventral region of ribs in the Geckos, Chamæleons, and some other forms, lying behind the sternum, which meet, pair by pair, in the ventral median line, thus completing a series of hoops encircling the abdomen. Inasmuch, as Dr. Gadow* justly points out, that

* Cambridge Natural History: Amphibia and Reptiles, p. 504.

these ribs bear "an extraordinary resemblance to the so-called 'abdominal ribs' of other reptiles," it is particularly to be regretted that the term has been used in so authoritative a work as the Catalogue to which reference has been made.

Since this confusion has been quite unnecessarily introduced, it will be as well to adopt the word "parasternum," already used by Fürbringer, Gadow, and others. The Lacertilia are at least generally supposed to be without a parasternum, which is one of the points of difference used to distinguish them from the genus *Sphenodon*. The above quotation from Dr. Gadow implies this general view, which is more explicitly stated in the 'Royal Natural History'*. I can find no statement in such works as that section of Bronn's 'Thier-Reich' which is devoted to the Lacertilia, as well as in other textbooks, to the effect that a parasternum is to be found in the Lacertilia; and I am therefore free to conclude that the knowledge of its actual occurrence is at least not widely spread.

In a brief preliminary note in 'Nature'† I pointed out the existence of a series of abdominal ribs in the Scincoid Lacertilian *Tiliqua scincoides*, and I herewith submit to the Society a more detailed account of these structures (text-fig. 29, p. 156), which I have not up to the present succeeded in observing in any other lizard.

The chevron bones of the abdominal-rib system are thin and not always easy to see; their slender bulk, as it appears to me, fully accounts for the fact that they have been previously overlooked. They are not nearly so stout, so numerous, or so closely adpressed as these bones are in an example of *Hatteria* of about the same size as the two specimens of *Tiliqua scincoides* which I have examined. For these reasons the bones would very readily be lost in preparing skeletons of *Tiliqua*. The distance separating the chevrons in *Tiliqua* is 8 mm., when the abdominal muscles are gently stretched but not overstretched; the same distance in the case of the dried abdominal skeleton of *Hatteria* was not more than 4 or 5 millimetres. In my specimen of *Hatteria* there were quite twenty of the chevrons; I could not detect more than seven in one of the two specimens of *Tiliqua*. In the other specimen these abdominal ribs were hardly at all obvious. The fact that these chevrons are quite independent of the ribs—and their purely superficial position, lying as they do in the ventralmost sheet of muscle of the abdominal wall—is in favour of regarding them as the homologues of the abdominal ribs of *Hatteria*. It remains, however, to be shown that they overlap the true ribs as the abdominal ribs do in *Hatteria*. The ribs in *Tiliqua* after the sternum do not apparently reach so far ventrally as they do in *Hatteria*. It might therefore conceivably be held that we had here to do merely with the ventral moiety of ribs which were defective laterally, and that the condition occurring

* "Another important feature in which the Order [Squamata] differs from all the preceding ones is the absence of any system of true abdominal ribs or of their equivalent a plastron" (vol. v. p. 107).

† May 5th, 1904, p. 6.

in *Tiliqua* was an imperfect representation of that occurring in the Chamæleon and other lizards, where a number of true ribs join ventrally behind the sternum. Thus in *Acontias* and *Typhlosaurus*, of which the former is a near ally of *Tiliqua*, there are present these post-sternal ribs meeting in the middle line, and thus simulating abdominal ribs*. In the Chamæleon the most ventral layer of the abdominal musculature is so thin that it requires a careful dissection to show that the ventrally meeting ribs do not lie in this layer but in the deeper layer. In *Tiliqua*, on the other hand, the ventral musculature is thick, and the two

Text-fig. 29.

Abdominal ribs of *Tiliqua scincoides*.

A points to one of these ribs. A meshwork of tendons lies between and over them.

layers are easily distinguishable. When the ventralmost layer is raised, the abdominal ribs are carried with it, and are seen to end off in it with slightly forwardly-curved lateral ends. But—more important than this—on the deeper layer of the musculature are two or three cartilaginous bars, lying obliquely (see text-fig. 30, p. 157), which are clearly the ventral portions of true ribs such as in *Acontias* make complete hoops. The discovery of these entirely sets at rest any doubt as to the fact that the bars of cartilage which lie superficially are really quite comparable to a parasternum. The true ventral moieties of the ribs are not in connection with their vertebral portions, so far as I have been able to ascertain. They would thus be very readily lost in macerated skeletons, and might even be overlooked in a dissection. In his 'Catalogue of Lizards

* Peters, 'Reise nach Mossambique,' Amphibia, pls. xii. & xiii.

in the British Museum,' Mr. Boulenger uses as part of his definition of the Scincidæ* the sentence "Ossified abdominal ribs are absent"; and in defining the Anelytropidæ† he includes in that definition the phrase "Abdominal ribs present." It is not absolutely clear from the wording used whether these two nearly related families are to be distinguished (*inter alia*) by the absence or presence of "abdominal ribs" (*i. e.*, as already pointed out, the ventral moieties of post-sternal ribs) or by the mere absence or presence of ossification in such ribs. In any case, not only has Peters figured complete hoops in *Acontias*, but I have been able

Text-fig. 30.

*Tiliqua scincoides*.

Ventral flap of musculature (**B**) in which lie the abdominal ribs, turned down to show the deeper-lying muscles (**C**), in which are imbedded the true ribs (**D**).

to show in the present communication that considerable vestiges of the ventral moieties of post-sternal ribs occur in *Tiliqua*.

It is to my mind possibly a matter for further enquiry as to how far the median ventral region of the post-sternal ribs which actually meet each other behind the sternum may not be actually a parasternum fused with true ribs. For the median region of the chevrons, whether of undoubted abdominal ribs or of true vertebral ribs, appears at the surface of the abdominal musculature. This median region, therefore, at least of the post-sternal true ribs may conceivably be a vestige of a parasternum in those *Lacertilia* where such ribs occur.

* Vol. iii. p. 130.

† Vol. iii. p. 430.

7. On the rare Rodent *Dinomys branickii* Peters. By
Dr. EMIL A. GOELDI, C.M.Z.S., Director of the Goeldi
Museum, Pará.

[Received May 16, 1904.]

(Plate X.*)

The zoological world was surprised in 1873 by the novelty of the discovery of a strange, large Rodent, introduced scientifically by Prof. Peters, then Director of the Berlin Museum, under the name *Dinomys branickii*. It was stated that the animal had been found in the neighbourhood of a town in Peru, wandering about in an orchard. It was further stated that the natives themselves were entirely unacquainted with the creature. Prof. Peters published a somewhat extensive memoir on the subject, based principally upon anatomical features, especially of the skin and the more or less complete skeleton. Up to this date I have not had the opportunity of consulting this memoir †, which I know only from a few lines of quotation in recent manuals on mammalogy, such as Flower and Lydekker, 'An Introduction to the Study of Mammals,' London, 1891, p. 489; and Beddard, 'Mammals,' London, 1902, p. 495 *seq.* These citations are barely sufficient to permit a certain identification of this peculiar form of Rodent and to exclude the possibility of confusion.

So far as the literature at my disposal goes, there is no indication of any living specimen having been examined by a zoologist, nor does there exist any notice of any further specimen as having been met with since 1873, so that the type specimen at the Berlin Museum ‡ remains till now the only one known to be in existence.

I have now the extreme good fortune to be able to make further additions to our knowledge of the subject. I consider the rediscovery of *Dinomys branickii* in the Amazonian region, from a general point of view, as the second most important

* For explanation of the Plate, see p. 162.

† Since beginning to write the present article I have received both the extensive memoir of Prof. Peters as well as the preliminary communication on the subject in the 'Monatsberichte der königl.-preuss. Akademie der Wissenschaften zu Berlin,' July-August 1873, pp. 551-552. Their contents correspond so nearly to my supposition that I find no necessity for changing anything in the wording of my note. The coloured lithographic figure given by Prof. Peters on plate i. identifies the animal satisfactorily, but, of course, can make no claim to rival the photographs taken from the living specimens, which give an essentially different conception of the animal's physiognomy. The most noteworthy difference consists in the fierce expression of countenance, resembling that of an angry rat ready to bite; while my photographs show a face which might be called the personification of perfect good humour. As I foresaw, there still exists no information as to the anatomy of the soft parts of *Dinomys*, which in all probability is still in reserve for me to bring to light.—April 7, 1904.

‡ On reading the memoir of Prof. Peters, I find—what was absolutely impossible to presume from the brief references in the above-cited manuals—that this type specimen does not belong to the Berlin Museum, but was only lent to its Director to be described by him, and that it forms part of the collections of the Warsaw Museum, for which it had been obtained by the Polish naturalist and explorer Constantin Jelski.



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DINOMYS BRANICKII.

scientific event that has occurred during the first decennium of the existence of the Pará Museum, after the refinding of the long-lost Dipnoan *Lepidosiren paradoxa*, as fully described in former volumes of the Zoological Society's publications.

My surprise was unbounded when, a few weeks ago, I received from a friend of the Museum, personally unknown to me, a cage containing a pair of live large Rodents entirely new to me, notwithstanding a twenty years' acquaintance with the Brazilian fauna, both from the South and the North. These, after a quarter of an hour of eager consultation of the more modern manuals of mammalogy, I recognised as being identical with the almost legendary *Dinomys branickii*, of which science had lost sight for thirty years.

It seems to me to be a most opportune occasion to publish a short description of the external features and the habits of *Dinomys*, as it is probable that the memoir of Prof. Peters, the only source of information on the subject up to the present, is deficient in these particulars. A series of photographs of the animal, taken in different attitudes spontaneously assumed, supplement my verbal explanations.

Doubtless the first impression from the general appearance, especially as regards size and external features, would ally the animal closely with the South-American "Páca" (*Agouti paca*); and the verdict of the scientist as to its systematic location has no reason to differ from the popular conception which has given to our Rodent the local name of "Páca-rána," a Tupy-term meaning "pseudo-páca." In size the older and larger specimen, the mother, is almost exactly of the dimensions of an average Páca; the young one is approximately half or two-thirds of that size. The similarity is increased by its capacious head, and the brownish colour marked with distinctly visible longitudinal rows of white spots. This similarity, however, begins to diminish as soon as one undertakes a more minute examination. It presents first the striking difference of having a hairy tail of about 2 decimetres in length. Still further, as regards the hair, while that of the Páca is soft to the touch and of even length, resembling somewhat the fur of the Otter, *Dinomys* has a rougher coat of stiffer hairs, uneven in length (these stiffer hairs being white-tipped and longer, and contributing to interrupt the uniformity of the general colour), and forming a first transition-step towards the quills of the coats of the Spiny Rats proper (Loncheridæ, Echinomyidæ). The white spots are located only on the rear part of the trunk, beginning from the shoulders. They are separated in two groups: (1) four longitudinal rows, nearly continuous at the fore part, the median line of the back being dark; (2) two lateral areas of more or less circular white spots occupying the flanks and thighs, scattered irregularly, as it would seem at first sight, but betraying a tendency to longitudinal arrangement on closer observation.

The form of the head of *Dinomys* may be described as sub-

pyramidal, while that of the *Páca* is subconical, due to its prominent cheek-bones and bulging eyes and the more slender snout. The former thus resembles more the head of the *Capybara*. What gives to the head a peculiar martial aspect are the immense white whiskers, equal in length to the animal's head, forming a thick tuft on each side. The nostrils are S-shaped, and have the same valvular arrangement for closing the aperture as the Manatee, for example, showing that the animal is adapted to a semi-aquatic life. While the prominent eyes of the *Páca*, like large black beads, have a glaring glossy aspect, the eyes of the *Dinomys* are not at all prominent, are of a soft light brown colour, the pupil being a vertical slit during the hours of daylight. They are thus of similar appearance to the eyes of certain smaller *Didelphyidae* (*Didelphys quica*, &c.) and of the large Two-clawed Sloth (*Choloepus didactylus*); and this similarity naturally leads to the conclusion that the animal is rather of nocturnal habits—a conclusion which is corroborated by actual observation. Both front and hind feet are four-toed. The general build of *Dinomys* is thick-set and inclined to corpulency. Due to the fact of setting the whole plantigrade sole on the ground, the hind feet especially, the *Dinomys* has a waddling gait, and reminds one of an immense rat well advanced in development towards a bear.

Both my specimens of *Dinomys* are of a peaceful, phlegmatic disposition; they are most excellent boarders in our Zoological Garden, and cause very little trouble on condition of having enough to eat. They devour prodigious heaps of provender, eating being one of their principal occupations both day and night. As far as observed up to the present, they show a preference for bread, squashes, and fruit of different indigenous palm-trees, such as the orange-coloured "*Tucumã*" (*Astrocaryum tucumã*). While eating, their favourite position is standing erect on the hind feet, and in this attitude there is a good opportunity of admiring the dexterous manner in which they can hold a fruit in their paws, notwithstanding the lack of the counter-pressure of a thumb. Such a fruit revolves in their grasp as though it were in the chuck of a slowly-turning lathe, and the large chips which fly fill us with respect for the immense gouging faculty of the large but comparatively slightly prominent incisors. The erect position while eating—which is the only attitude thus far observed while taking food—reminds one more of the "*Cutia*" (*Dasyprocta*) among the larger South-American Rodents, and forms a noteworthy difference from the "*Páca*," which I have never seen eating in any other position than on all fours.

The predominant feature of the character of *Dinomys* is a combination of leisurely movements and supreme good nature. It knows absolutely nothing of haste. Spending the greater part of the day sleeping in a corner—the mother often lying upon the young one, or standing over it, as if to protect and to keep it warm—opening its half-closed eyes only when it hears the

approaching steps of the keeper, it forms the resolution to move with slow gait, expecting some food, evidently governing its movements as much by hearing and smell as by sight. It is not easily irritated, and permits one to stroke and to scratch its head and back, and only occasionally manifests its displeasure by a low guttural growl. I have never yet observed a manifest intention to bite. When let out of the cage it makes no attempt to escape, and limits its excursions to an exploration of the immediate neighbourhood in search of something to eat. It occasionally scratches itself rapidly with its long claws, which is the only occasion on which it manifests a capacity for rapid movements when required. One thing not yet definitely verified by us is its proclivity for digging, the development of the claws at least leading to the supposition that the animal is well fitted for that purpose. The amiable relations always existing between mother and son prepossess one most favourably as to the natural disposition of the animals*.

This phlegmatic disposition seems to me to be a very precarious endowment for the struggle for life; and considering the evident advantages which result to the smaller domestic rodents, such as rats and mice, from their nervously active constitution, it would not be strange if the species should tend to disappear. The apparent rarity of *Dinomys* may possibly find its explanation in the consequences of such a psychological endowment in a more nervous environment; but it is also possible that this rarity is because of the circumstance that the real habitat of the species has not yet been clearly ascertained. As matters now stand, it would be justifiable to suppose that the true home of *Dinomys* is not properly in the Peruvian Andes, and that the first specimen found there was merely a stray individual, and that its actual habitat may rather be located in the almost unexplored regions of the eastern slopes and tablelands of the Bolivian and Peruvian foot-hills bordering on Brazil, including geographically the headwaters of the rivers Acre, Purús, and Juruá. I shall soon have occasion to show that a scientific exploration of the region above described will result in a multitude of great surprises both from a zoological and a palæontological point of view, of which the interesting rediscovery of the lost *Dinomys branickii* is only a first instalment.

Para, 7th April, 1904.

P.S.—Unfortunately, just before I send this note, the older *Dinomys*, the mother, has died owing to a difficult parturition. One fœtus was born under normal conditions, while the other, apparently on account of its abnormal position, could not be

* After this portrayal of the animal's peaceful character, it will not seem strange that the account of the capture of the first individual in 1873 in the Peruvian mountains, as furnished by Prof. Peters, according to which it was deemed necessary to deal two powerful sabre-strokes to lay the terrible monster low, always amuses me.

delivered. This unforeseen event will now give, much sooner than I expected, an opportunity to fulfil my promise to undertake a thorough study of the anatomy of the soft parts, as well as of the two fully-developed fœtuses.

14th April, 1904.

EXPLANATION OF PLATE X.

Dinomys branickii, from photographs of two living examples (a mother and young) (about $\frac{1}{2}$ nat. size), and the skin of the former (about $\frac{1}{2}$ nat. size) in the Goeldi Museum, Pará.

8. The Black Wild Cat of Transcaucasia.

By C. SATUNIN, of Tiflis, C.M.Z.S.

[Received May 16, 1904.]

Although the existence in Transcaucasia of a Black Wild Cat was known long ago, the animal has never been described nor scientifically named.

Hochenacker speaks of this cat, so far back as 1837*, as a *Felis cato affinis*; but as all his text is in Latin, this cannot be regarded as a scientific name for the animal. I myself have mentioned this cat as *Felis* sp. in my paper on the Fauna of the Caucasus†, as well as in the Catalogue of the Caucasian Museum‡; but I have not had the opportunity of giving a description of it until now.

That it really is a Wild Black Cat I knew well, as all the specimens I have had the opportunity of examining were alike, and as it is by no means rare in its native haunts.

There remained one important point to decide about this animal, namely, Was it not a melanic form of the common Wild Cat, *Felis catus* L.?

Thanks to the material in the Zoological Museum of the St. Petersburg Academy of Sciences, where I have found two mounted specimens, three skins, and three skulls of this cat, I am now certain of its specific validity, and I name it *Felis daemon* §, of which the following is the description:—

Size of a big male domestic cat. Colour ranging from black with a slight reddish tinge to reddish dark brown. This colouring is somewhat lighter on the under side of the body, on the inner surface of the extremities, and on the distal under surface of tail. Very long white hairs are scantily dispersed all over the body.

In a certain light, dark-black transversal stripes are visible on the sides of the fore part of the body, these stripes being more conspicuous on somewhat faded skins.

The whiskers, as well as the eyebrow-bristles, are brown.

The tail is considerably longer than in *Felis catus*.

Claws white, transparent, and with a mother-of-pearl lustre.

* Bull. Soc. Nat. Moscou, 1837, p. 136.

† Zool. Jahrb., Syst. ix. p. 289 (1897).

‡ 'Museum Caucasicum,' i. p. 24 (1899).

§ "Daemon" being the hero of several Caucasian legends, and also of the poem by Lermontoff with the same title

The measurements, in millims., of the two mounted specimens and of the three skins are :—

	Mounted specimens.		Skins.		
	No. 671.	No. 2685.	No. 2997.	No. 3001.	No. 4945.
From tip of nose to base of tail	610	560	610	750	690
Tail, hair included	355	340	340	380	370
Ear, from external base ...	51	51	—	54	46

Skull: as compared with the skull of *Felis catus* that I have had for comparison, the three skulls of this new cat differ only in that the frontal part is somewhat narrower. Moreover, in *Felis catus* the nasals reach further back than the ascending branches of the upper mandible, whereas in *Felis demon* the upper mandibular bones go further back than the nasals.

The measurements of two complete skulls, in millims., are :—

	No. 2997.	No. 3001.
	♂.	♀.
Greatest length	98	101
Basilar length	81	81
Greatest breadth across the zygomatic bones	69·5	71
Smallest breadth behind the postorbital process	31·2	34
Smallest breadth between the interorbitals.	19	20
Greatest breadth of brain-case	46	46·5
Length of bony palate	36	33
Width between upper premolars	38·5	39·5
Condylar length of maxilla	61	64

Felis demon is not scarce in the woods of the southern slopes of the chief range of the Caucasus (Nookhinsky district of Gouv. Elizabethpol) and the Zakatalsky Province. It used to be found, according to Hochenacker, also in the mountains of the Small Caucasus; but nothing is heard of it there at the present time. According to Radde, this cat inhabits the Kopet-Dagh Range in Transcaspia; and M. S. Alphéraky tells me that it is by no means rare in the woods of Borshom, where it is often trapped, together with *Felis catus* and other vermin. Habits unknown.

9. On a Buffalo-Skull from East Central Africa.

By R. LYDEKKER.

[Received May 17, 1904.]

(Text-figure 31.)

[The complete account of the new form described in this communication appears here; but since the name and preliminary diagnosis were published in the 'Abstract,' the species is distinguished by the name being underlined.—EDITOR.]

Through the kind offices of Rowland Ward, Limited, the British Museum has recently been presented with the skull and tail-tip of a bull Buffalo, killed by the donor, Mr. Arnold Mathews,

of Ballynahinch Castle, Co. Galway, in the Mfumbiro district, on a volcanic mountain west of Kiva, on the borderland between the Congo Free State and German East Africa, in forest at an elevation of between 7000 and 8000 feet. These specimens I cannot identify with any described form, and therefore propose to regard them as representing a new race of African Buffalo.

Although I cannot find Mfumbiro in any atlas, I take the district in question to be the area lying between the Albert Nyanza and Tanganyika, that is to say, approximately, the Mapi country.

The following note on the Buffalo to which the specimens belonged has been communicated by Mr. Mathews:—

“The hide of this animal is not bare like that of the South-African Buffalo, but covered with a dense crop of black hair all over. The height of the buffalo is considerably less than that of the big South and East African races. The animal seems to me to be a race midway between the Congo and the East-African Buffalo. It shows, however, no tendency to red. In addition to its small size, peculiar shape of horns, and density of pelt, the only peculiarity I noticed was that the tail had a white tip. I shot another bull out of the same herd, exactly like the one of which I sent you the skull, only younger and smaller.”

The skull and horns are evidently those of a fully-adult bull, and the latter present the following measurements:—

Along outer curve	21·5 inches.
Basal girth	19·7 ,,
Greatest span	25·5 ,,
Tip to tip interval	15·0 ,,

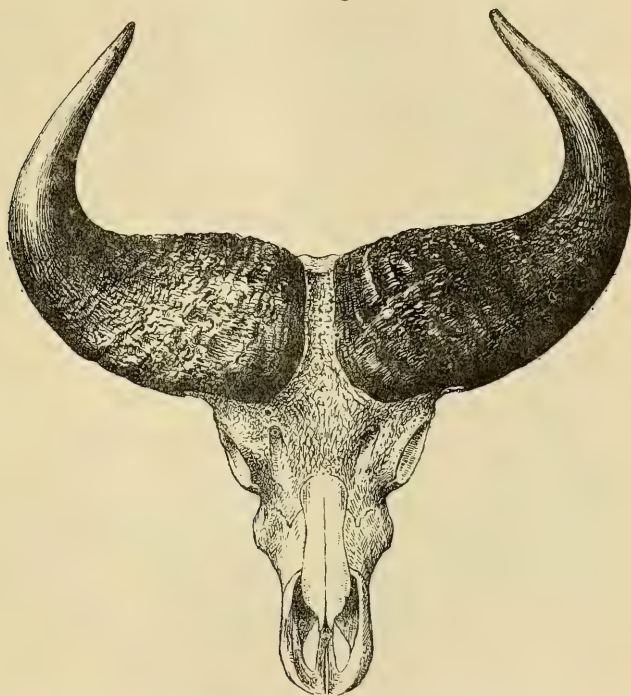
Compared with the various local forms included in my work on ‘Wild Oxen, Sheep, and Goats,’ under the specific title of *Bos* (*Bubalus*) *caffer*, the skull and horns of the present form come nearest to those of *B. caffer nanus* of the Congo region. They are, however, considerably larger than the latter; and the horns (text-fig. 31, p. 165) are thicker, less sharply incurved, and with a much more sinuous front surface, bending sharply backwards immediately behind the basal frontal expansion, and then curving somewhat forwards with the commencement of the inward inclination. An interval of about an inch and a half separates the two horns in the middle of the forehead. Speaking generally, these appendages are intermediate between those of the Cape and those of the Congo Buffalo, although on the whole nearer to the latter. Here it may be mentioned that there is an almost complete gradation, as regards the extent of the frontal sinuosity, from the horns of the Cape Buffalo through those of the present and the Congo forms, to the Senegambian race (*B. caffer planiceros*), in which this curvature is practically obsolete.

From the typical red Congo Buffalo (*B. c. nanus*) the present form differs by its deep-black coat, whereby it agrees with the Cape animal, from which, however, it is broadly distinguished by the dirty-white tail-tuft. In reference to Mr. Mathews’s note,

it may be mentioned that two Cape Buffaloes in the British Museum have a well-developed coat of black hair.

As this Buffalo has obviously nothing to do with the one from East Africa recently described by Mr. Thomas*, I propose to regard it as a new race, under the title of *Bos caffer matheusi* (cf. Abstr. P. Z. S. 1904, no. 9, p. 10, June 14), the Museum specimens being of course the types. It may be shortly defined as a race of the approximate size of *B. c. nanus*, but with the abundant hair black instead of red, and the tail-tuft white; the horns being at the same time larger, more curved outwardly, and then inclined backwards near the lateral bend.

Text-fig. 31.



Front view of skull of male Buffalo, *Bos (Bubalus) caffer matheusi*, from the Mfumbiro district of East Central Africa. $\frac{1}{2}$ nat. size.

I always feel I owe an apology to naturalists when adding to the list of subspecies; but the present form has certainly claim to recognition, on account of its tending to connect the Cape with the Congo Buffalo—two forms which at one time I had some compunction in regarding as specifically the same.

* P. Z. S. 1904, vol. i. p. 371.

10. The Ichang Tufted Deer. By R. LYDEKKER.

[Received June 3, 1904.]

(Text-figures 32 & 33.)

[The complete account of the new species described in this communication appears here, but since the name and preliminary diagnosis were published in the 'Abstract,' the species is distinguished by the name being underlined.—EDITOR.]

The genus *Elaphodus* has been hitherto known by two species—the typical *E. cephalophus* and the perfectly distinct *E. michianus*, from the Ningpo district, province of Chekiang, on the east coast of China. I am now able to add a third. A few days ago Mr. A. E. Leatham called at the Natural History Museum, bringing with him for determination the skull and skin of a young male Tufted Deer (*Elaphodus*), shot by himself last January in the mountains near Ichang, province of Hupei, Central China. Ichang, it may be mentioned, is fully a thousand miles from Ningpo; and the deer killed by Mr. Leatham was shot high up in the mountains far away from water, whereas *E. michianus* is reported to inhabit the reed-brakes on the Ningpo rivers. On looking through the specimens in the British (Natural History) Museum, I found an adult male skin and skull of an *Elaphodus* from Ichang, collected by Mr. F. W. Styan in 1901 (B.M. No. 1.3.2.17).

Externally, Mr. Leatham's specimen of the Ichang Tufted Deer differs from *E. michianus* by its decidedly darker and more uniform colour, which is blackish brown, passing almost into black on the limbs, while there is more white on the tail, of which only the basal two-thirds of the upper surface is dark, so that the whole of the tip is white.

The skin of the adult male sent by Mr. Styan is browner, except down the middle of the back, but exhibits the same uniformity in general colour. How different these skins really are in colour from that of *E. michianus*, it is not easy to determine, seeing that the specimens of the latter in the Museum are more or less faded by exposure.

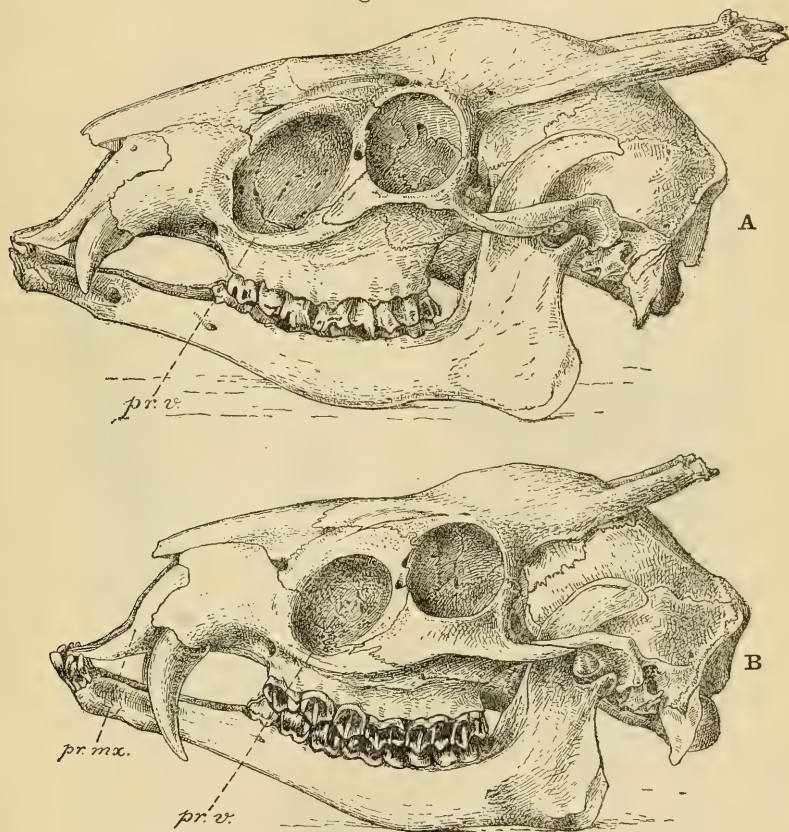
On comparing the skull of Mr. Leatham's specimen, which is immature and retains the milk-molars, with a skull of a male *E. michianus* of nearly the same age, I find that the nasal bones are absolutely and proportionately shorter in the former, their length being $1\frac{1}{8}$ inch against $2\frac{1}{8}$ inches. Moreover, their length is contained $3\frac{1}{4}$ times in the basicranial length, instead of less than 3 times. Another distinction is to be found in the form of the anterior upper milk-molar, which is much shorter (antero-posteriorly) in the Ichang than in the Ningpo skull; and there also appear to be slight differences in the form of the upper molars.

Both skulls, it may be observed, show no trace of the pedicles of the antlers, which must accordingly be very late in development.

Equally noteworthy differences are presented when the adult

skull (text-figs. 32 & 33, **A**) obtained by Mr. Styan at Ichang is compared with an adult male skull of *E. michianus* from Ningpo (No. 78.11.14.3) (text-figs. 32 & 33, **B**), the latter being somewhat older than the former. The Ichang skull shows the shortness of the nasals characteristic of the immature specimen, the length of these bones being $2\frac{1}{8}$ inches, against $3\frac{1}{2}$ inches in *E. michianus*.

Text-fig. 32.



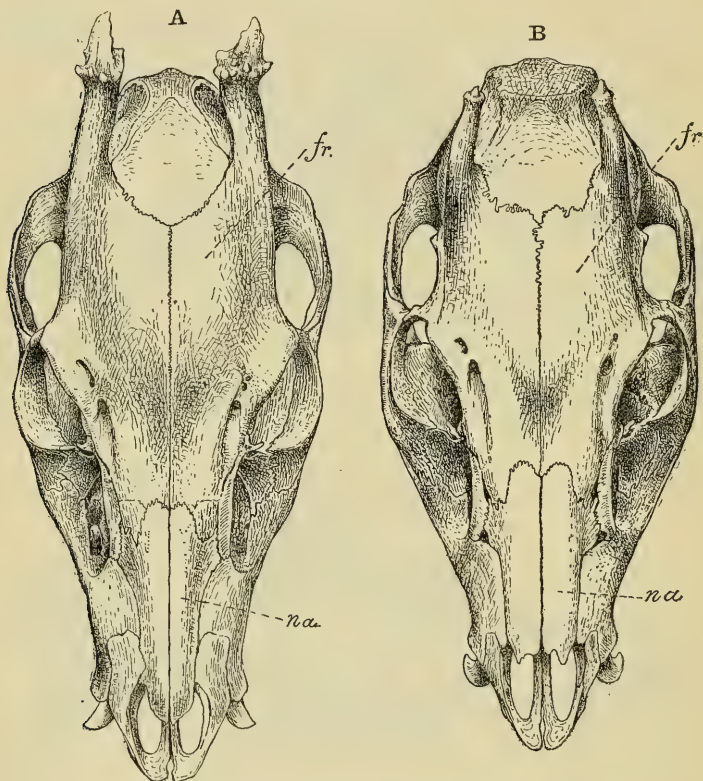
Left lateral view of adult male skulls of *Elaphodus michianus* (**A**), and *E. ichangensis* (**B**).

pr.mx., premaxilla; *pr.v.*, preorbital cavity.

The antler-pedicles are much more developed in the Ningpo skull, and have a much more outwardly-directed ridge connecting them with the orbit (as shown in text-figure 32, **A**); but this feature may be due, to some extent, to difference in age. The flat surface of the jugal below the orbit is quite narrow in the Ningpo, but

broad in the Ichang skull. Very noticeable is the difference in the form of the preorbital fossa, which is rounder, deeper, and less oblique in the Ichang skull. More striking still is the difference in the canines of the two forms, that of the Ichang skull being nearly twice the length of that of the older Ningpo specimen, as well as differing somewhat in shape. Such differences cannot possibly, I think, be accounted for by wear, as I cannot conceive

Text-fig. 33.



Front view of adult male skulls of *Elaphodus michianus* (A)
and *E. ichangensis* (B).
fr., frontal; na., nasal.

how such tusks could become worn, while those of the Ningpo skull show no signs of wear. I may add that the figured skulls differ in the form and relations of the premaxillæ, but I find this to be a very variable feature.

Compared with a female skull of the typical Tibetan *E. cephalophus* in the British Museum (No. 92.7.13.1), which is the only specimen of the latter species available, the adult Ichang skull

makes a much nearer approach than it does to that of *E. michianus*, showing a similar conformation of the bones below the orbit, and apparently also a very similarly shaped preorbital cavity. The nasal bones are, moreover, of much the same relative length, their long diameter being one third of the basicranial length. On the other hand, *E. cephalophus* is at once distinguished by its greatly superior size, as is shown by the following table of the basicranial lengths of the four skulls available for comparison :—

<i>E. michianus</i> , male.....	6 $\frac{1}{2}$ inches
" female.....	6 $\frac{3}{4}$ "
Ichang adult male	6 $\frac{3}{8}$ "
<i>E. cephalophus</i> , female	7 $\frac{1}{4}$ "

From this it is obvious that the Tibetan skull cannot possibly be the female of the form indicated by the adult Ichang specimen.

If a male skull of *E. cephalophus* were available for comparison, I have little doubt that important differences between it and the Ichang specimen might be detected. As it is, the former species appears to have a much longer type of skull than the Ichang animal, from which it is also distinguished (so far as can be determined) by the much more solid structure of the walls of the preorbital cavity.

In any case, the Ichang Deer is broadly distinguished from the Tibetan *Elaphodus cephalophus* by its greatly inferior size.

The foregoing differences seem to leave no doubt as to the specific distinctness of the Ichang Tufted Deer, which may be named *Elaphodus ichangensis* (cf. Abstr. P. Z. S. 1904, No. 9, p. 10, June 14). It is characterised, as compared with *E. michianus*, by its darker and more uniform colour, whiter tail, smaller antlers, larger tusks, shorter nasals, and smaller, deeper, and more evenly circular preorbital fossa; while it is smaller than *E. cephalophus*.

The type will be the aforesaid adult male skull, collected by Mr. Styan.

In conclusion, I may take the opportunity of referring to the skull of a female Tufted Deer (B.M. No. 98.3.7.18) obtained, together with the skin, by Mr. C. B. Rickett at Fing-ling, Fokien, lying considerably to the south of Ningpo. This skull is of the same general type as that of the female of *E. michianus*, but differs by its superior size, the basicranial length in the two specimens being respectively 6 $\frac{3}{4}$ and 6 $\frac{1}{4}$ inches. The Fokien skull is further distinguished by the less marked elevation of the hinder half of the frontal region, which does not develop a median crest, and by the expansion and flattening of the platform formed by the base of the preorbital cavity and the anterior zygomatic root. There are also differences in the form of the paroccipital process in the two skulls, which, with other details, and their marked difference in size, appear to justify the reference of the Fokien Tufted Deer to a separate race, under the name of *Elaphodus michianus fociensis*.

11. On Two New Labyrinthodont Skulls of the Genera *Capitosaurus* and *Aphaneramma*. By A. SMITH WOODWARD, LL.D., F.R.S., F.Z.S.

[Received June 3, 1904.]

(Plates XI. & XII.*, and Text-figure 34.)

Among the remains of Labyrinthodonts acquired by the British Museum during recent years, there are two skulls of unusual interest. One was obtained from the Triassic sandstone of Staffordshire, while the other was found in a formation, apparently of the same geological age, in Spitzbergen. The first specimen is of importance as displaying the occipital region of the skull more clearly than any Labyrinthodont hitherto described; and the second specimen adds facts concerning the shape and relations of the quadrate bone. Each fossil represents a new species, while the second is the only skull of a Labyrinthodont as yet described from the Arctic Regions.

I. *CAPITOSAURUS STANTONENSIS*, sp. nov. (Plate XI.)

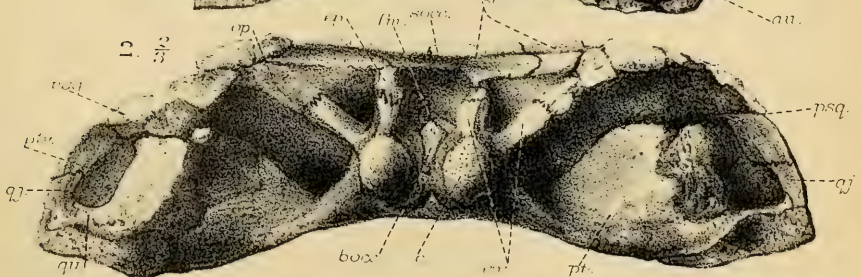
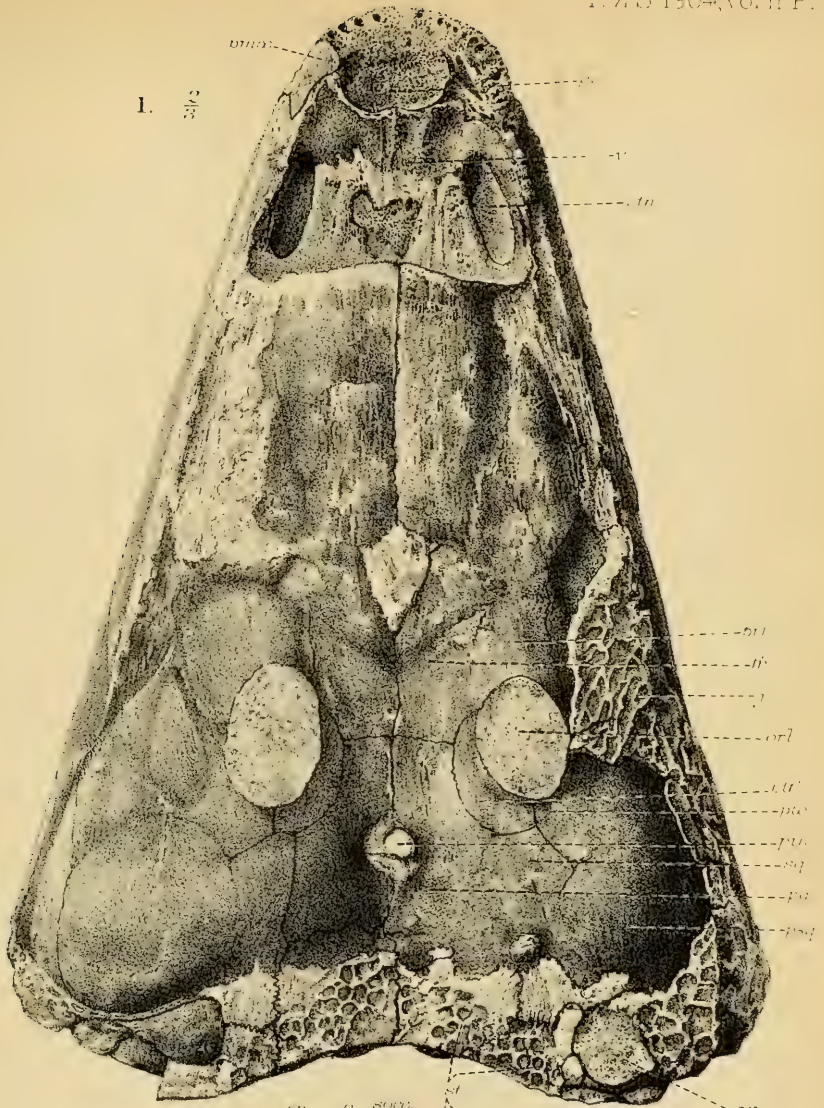
The discovery of the Staffordshire specimen in the Lower Keuper sandstone of Stanton, near Uttoxeter, was briefly noticed by Mr. John Ward four years ago†. The block of sandstone containing the skull was split along the plane of the cranial roof, leaving most of the roof-bones adherent to one slab, while the impression of these, with the rest of the skull, remained in the counterpart-slab. When Mr. Ward examined the fossil it was still in the condition in which it had been exposed by the accidental fracture; so that his description could only be of a general and preliminary nature. Since its acquisition by the British Museum, both parts of the specimen have been skilfully prepared by Mr. C. Barlow; and the principal characters of the skull, as now observable, are illustrated in Plate XI.

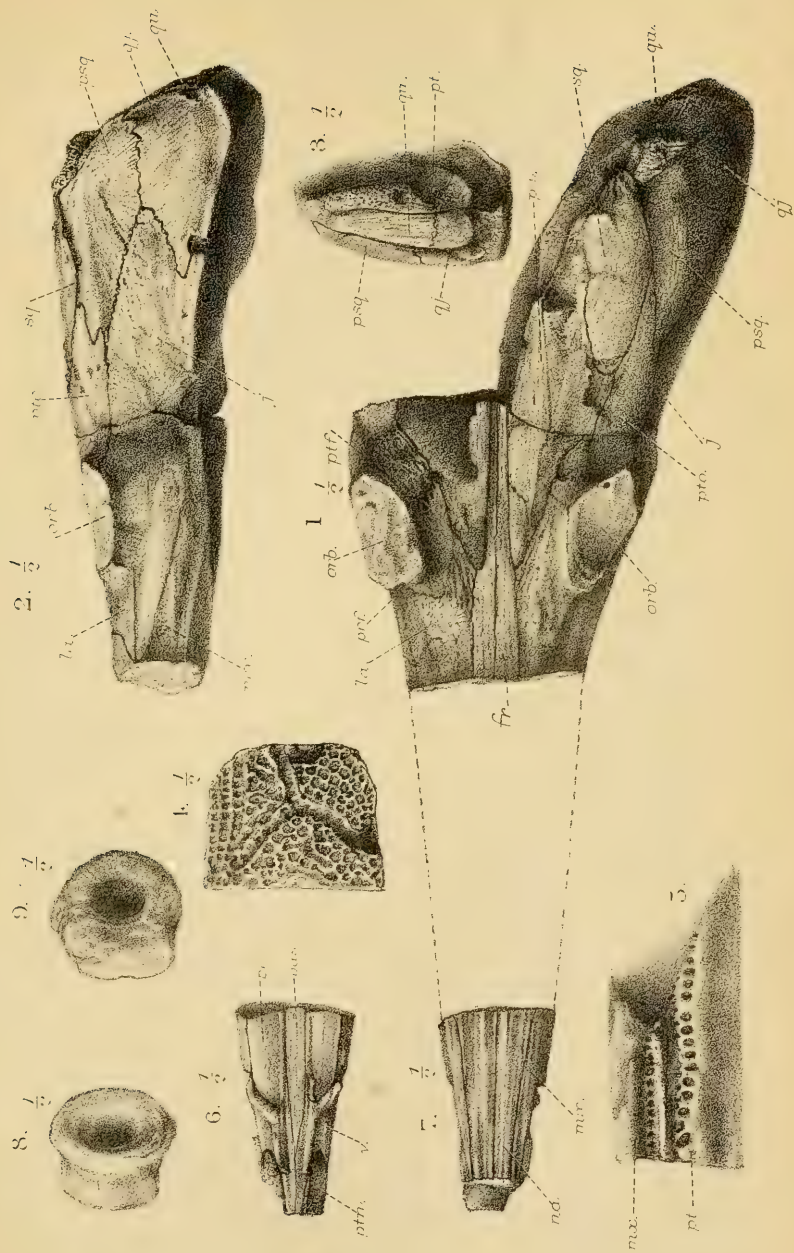
The skull does not appear to have been much distorted by crushing, and its shape closely resembles that of the skull of a broad-nosed crocodile. All the external bones are similarly ornamented with a coarse network of sharp ridges. The occipital border is slightly excavated, and the deep notches for the auditory meatus (*au.*) are nearly, if not completely, surrounded by bone. The specimen is a little fractured in this region. The orbits (*orb.*) are set far back, only of moderate size and regularly oval in shape, with the long axis directly antero-posterior, not oblique. The pineal foramen (*pin.*) is a rather large circular vacuity.

* For explanation of the Plates, see p. 176.

† J. Ward, "On the Occurrence of Labyrinthodont remains in the Keuper Sandstone of Stanton," Trans. N. Staffs. Field Club, vol. xxxiv. (1900), pp. 108-112, pls. iv., v.

1. $\frac{2}{3}$





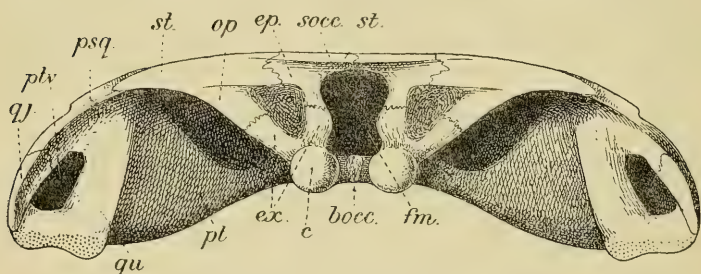
The sutures between the roof-bones in the hinder half of the skull are clear on both sides of the fossil; but the elements in the rostral region cannot be distinguished. There are the usual two pairs of small bones forming the occipital margin between the auditory notches, the middle pair being larger than the lateral pair. The parietal bones (*pa.*) are a symmetrical pair, twice as wide in their posterior half as in their anterior half, and truncated in front where they meet the frontals (*fr.*). Their maximum width is less than their total length, and the pineal foramen is situated at their middle point. The frontals just enter the rim of the orbit at its antero-internal portion; but the parietals are completely excluded from this rim by the antero-posteriorly elongated postfrontals (*ptf.*). The squamosal element (*sq.*) is longer than broad, articulating in front chiefly with the post-orbital, but also meeting the postfrontal. The postorbital (*pto.*) forms the posterior and half the externo-lateral rim of the orbit; the jugal (*j.*) enters the outer portion of this rim; while the prefrontal (*prf.*) completes it in front. The large prosquamosal (*psq.*) is about two-thirds as deep as long, tapering to a point forwards. The quadrato-jugal (*qj.*) is about two-and-a-half times as long as deep, also tapering to a point forwards, and extending slightly downwards below the level of the tooth-bearing edge of the upper jaw. The jugal (*j.*), as usual, is irregularly triangular in shape, with the radiating ridges of its ornamentation predominant.

At the rostral end of the fossil represented in Plate XI., the cranial roof and underlying matrix are removed to expose the palate from above. The antero-posteriorly elongated posterior nares (*ptn.*) are thus well seen; and the hinder edge of the large premaxillary vacuity (*pv.*) is also preserved. The posterior limit of the premaxilla (*pmx.*) is distinct on the left side. The extensive vomerine plates (*v.*), divided by a median suture, are also well preserved. The premaxillary teeth, shown in transverse section, are small, uniform in size, and arranged in close series. The maxillary teeth, exposed in side view, are similar. Each tooth appears to have been a hollow cone with plicated walls. An excavation in the sandstone reveals hollows left by the decay of the usual large teeth, which occur on the palate in front of and behind the posterior narial openings.

As already mentioned, the most interesting part of the skull is the occipital region, which is especially well preserved (fig. 2). It does not project sufficiently far backwards to admit of the occipital condyles being seen when the cranium is viewed directly from above. The position of the foramen magnum (*fm.*) is clear; while a vacant space (*socc.*) between this and the roof-bones of the occipital border suggests that a supraoccipital element was present but unossified. Below the middle of the foramen magnum there is a narrow tongue of bone (*bocc.*) separated by a little matrix from the prominent occipital condyles. This is probably

to be interpreted as a partially ossified basioccipital element forming only an insignificant part of the occiput. The condyles themselves (*c.*) are convex and seem to have been covered with unossified cartilage, while they constitute the hindmost end of a pair of bones which enter extensively into the base of the cranium and also rise upwards to bound the foramen magnum on each side. These elements (*ex.*) therefore exhibit the same disposition as the exoccipitals of a frog, and must be homologous with the latter. They are pierced by the foramen for the vagus nerve, which is well seen on the left side. The posterior face of each exoccipital immediately above the condyle is impressed with a triangular fossa, so that the upper end of the bone, partly obscured by matrix, has the appearance of bifurcating to unite in jagged sutures with the two bones which descend from the occipital row of roofing plates. The latter plates are evidently superficial in origin—either dermal or splint ossifications—but there is no clear line of demarcation between them and the immediately underlying bones just mentioned. The inner half of

Text-fig. 34.



Capitosaurus stantonensis; hinder view of occiput, restored, two-thirds nat. size.

bocc., supposed basioccipital; *c.*, occipital condyle on exoccipital; *ep.*, epiotic; *ex.*, exoccipital; *fm.*, foramen magnum; *op.*, opisthotic; *psq.*, prosquamosal; *pt.*, pterygoid; *ptv.*, postero-temporal vacuity; *qj.*, quadrato-jugal; *qu.*, quadrate; *socc.*, space for supraoccipital; *st.*, supratemporals.

each plate of the median pair would directly overlap the cartilaginous supraoccipital; while its outer or lateral half alone is underlaid by the bone (*ep.*) which occupies the place of a piscine or amphibian epiotic. The inner two-thirds of each plate of the outer pair is underlaid by the second bone (*op.*) of triangular shape, which exhibits the usual relationships of an opisthotic. As shown on the right side of the fossil, the jagged suture between these two otic bones coincides exactly with that dividing the two overlying plates. The pterygoids unite in a deeply jagged suture with the broad basioccipital region, and then expand behind on each side into a vertical lamina (*pt.*) which articulates with

the inner edge of the quadrate (*qu.*). The quadratojugal is in contact with the quadrate only at its lower end, thus leaving a rather large postero-temporal vacuity (*ptv.*) which is especially well seen on the left side.

The complete occipital region, as here interpreted, is shown in the accompanying restored sketch (text-fig. 34, p. 172). It obviously conforms much more closely to the Amphibian type than to the arrangement in any known reptile. It therefore agrees with the evidence derived from the palate and the supratemporal plates, showing that the Labyrinthodonts are Amphibia.

The characters of the cranial roof, the anterior end of the palate, and the teeth, prove that the skull now described belongs to the genus *Capitosaurus*. It cannot, however, be referred to any of the known species of this genus. It differs from the skull of the type-species, *C. arenaceus*, from the Keuper of Franconia*, in the narrower and more tapering form of its rostral region, the more elongated shape of the orbits, and its more nearly circular pineal foramen. It is distinguished from the skulls of *C. nasutus*† and *C. robustus*‡, among other characters by the slighter excavation of its occipital border and by the shape of the outer pair of its supratemporal plates. It is also distinguished from the imperfectly known skull of *C. fronto*§ by the different shape of its auditory notch and the coarseness of its external ornamentation. The new specimen therefore represents a hitherto unrecognised species, which may be named *C. stantonensis*.

II. APHANERAMMA ROSTRATUM, gen. et sp. nov. (Plate XII.)

The imperfect Labyrinthodont skull from Spitzbergen was found by Profs. J. W. Gregory and E. J. Garwood in the Trias of Sticky Keep, associated with a few short and deep, biconcave vertebral centra, which probably belonged to the same animal. It is broken into five pieces, which show little beyond impressions of the bones. Three fragments are internal moulds, while the other two pieces bear marks of the exterior. The right half of the postorbital region and the middle portion of the rostrum are missing. Enough, however, is preserved to indicate that the skull must have been of a much elongated shape, with a slender snout. It is very little depressed behind, and the occipital plane slopes backwards. Its external surface was ornamented with large reticulating rounded ridges, which were sometimes interrupted, as shown by the impression of part of the left cheek

* Graf zu Münster, Neues Jahrb. für Min. 1836, p. 580; H. von Meyer, 'Die Saurier des Muschelkalkes' (1847-55), p. 152, pl. lix. figs. 5-7.

† H. von Meyer, Paläontogr. vol. vi. (1858), p. 222, pls. xxiv.-xxvi.

‡ H. von Meyer, 'Die Saurier des Muschelkalkes' (1847-55), p. 146, pl. lix. figs. 1-4, pl. lxi. fig. 10. *Cyclotosaurus robustus*, E. Fraas, Paläontogr. vol. xxxvi. (1889), p. 121, pls. ix., x., pl. xi. figs. 1-4.

§ H. von Meyer, Paläontogr. vol. vi. (1858), p. 229, pl. xxviii. fig. 2.

(fig. 4). The grooves for the slime-canals must also have been deep and conspicuous, as shown by the same fragment.

The most interesting feature in the skull, its quadrate bone (figs. 1-3, *qu.*), is well preserved on the left side and exposed from behind. This bone is long and narrow, antero-posteriorly compressed, and inclined somewhat backwards. Its inner face is sheathed by a great vertical plate of the pterygoid, while its outer or lateral border is in complete contact with the bones of the cheek. It is quite clear that there was no postero-temporal cleft or vacuity; and the quadrate bears no impression of the external auditory meatus.

There are no vacuities in the bony covering of the postorbital region of the cheek, and the limits of some of its constituent elements are well shown by the natural internal mould. The long and narrow ovoid squamosal (figs. 1, 2, *sq.*) is distinct; while the outline of the equally elongated and still narrower postorbital (*pto.*) can be traced without difficulty. There can also be little doubt that the postfrontal (*ptf.*) and prefrontal (*prf.*) exclude the parietals and frontals from the margin of the orbit. The parieto-frontal region, however, cannot be satisfactorily interpreted. It seems probable that the parietals (*pa.*), which must have been relatively large, taper rapidly in front, where they extend nearly to the anterior border of the orbit. They must also have been either depressed or thickened in the median portion, where their anterior end articulates with the very narrow pair of frontals (*fr.*)—suggesting an arrangement nearly like that represented by Cope in the skull of *Cricotus* *. The prosquamosal (*psq.*) is an irregularly triangular plate, somewhat longer than deep, with the apex forwards. The quadrato-jugal (*qj.*) is nearly twice as long as its maximum depth. The jugal (*j.*) is especially elongated and forms the greater part of the infero-external border of the orbit (*orb.*), which is oval in shape and directed both laterally and upwards. There are also some traces of the edge of the postfrontal (*ptf.*), prefrontal (*prf.*), and lachrymal (*la.*) bones, but the middle part of the rostrum is lost. An internal mould of nearly the terminal portion of the snout (figs. 6, 7) demonstrates the slenderness of this region and the elongated shape of the nasal bones (*na.*).

The palate is of the typically Labyrinthodont pattern, with a complete parasphenoid (fig. 6, *pas.*), which is laterally compressed in its middle portion. The large posterior lamina of the pterygoid, in a vertical plane, abutting on the quadrate, has already been mentioned. In front of this expansion the pterygoid of each side curves outwards to meet the jugal (and probably also the hinder end of the maxilla) in a long suture. Its extent anteriorly is uncertain owing to the absence of the middle of the rostrum. Further forwards the palatines (fig. 6, *pl.*) are rather

* E. D. Cope, Proc. Amer. Phil. Soc. vol. xvii. (1878), p. 529.

broad plates; while the vomers (*vo.*) bound the antero-posteriorly elongated posterior nares (*ptn.*) both behind and within. The only teeth observable are indicated by an impression of the middle part of the pterygoid region (fig. 5), where they occur chiefly in two close parallel rows, one on the outer edge of the pterygoid (*pt.*), the other on the maxilla (*max.*). The teeth of each series are nearly uniform in size, but those of the pterygoid are somewhat larger than those of the maxilla. They are all cones with the usual thickened and folded walls. There are also traces of an irregular patch of minute teeth or tubercles still further back on the pterygoid.

Three vertebral centra found in the same formation and locality as the skull are deeply-biconcave discs, not pierced by any foramen for the passage of a remnant of the notochord. One obliquely crushed specimen is shown of the natural size in Pl. XII. fig. 8, and another imperfect specimen is similarly represented in fig. 9. The concavity at the end of the centrum is very slight near the outer rim and suddenly deepens towards the centre.

It is difficult to determine the precise affinities of so fragmentary a Labyrinthodont skull, but if the vertebral centra are rightly ascribed to the same animal, it evidently represents one of the higher members of the Order. Though suggestive in some respects of *Cricotus*, as already mentioned, the new skull differs from that of Cope's genus in the thickening or depression of the middle part of the parietals, and in the very strong external sculpture. The associated vertebral centra also differ from those of *Cricotus* in being completed discs. Among other Labyrinthodonts, the specimen from Spitzbergen seems to approach most closely the skull of *Trematosaurus**, with which it agrees in its general shape, external sculpture, dentition (so far as seen), and the relations of the quadrate bone. It is distinguished, however, by the peculiar disposition of the parietal bones. The new fossil thus represents a hitherto unknown genus, which may be named *Aphaneramma* and defined as follows:—Skull elongate-triangular, with the orbits widely separated and situated in its hinder half; external bones strongly sculptured, and grooves for slime-canal deep. Parietal bones extending forwards between the orbits; frontals very long and narrow: both these elements excluded by the postfrontals and prefrontals from the orbital border. A single regular row of small teeth on the pterygoid parallel with the equally uniform row of teeth on the maxilla; clustered small teeth or tubercles further back on the pterygoid. Vertebral centra complete biconcave discs, not perforated. The type-specimen of the type-species, *A. rostratum*, is the imperfect skull now described.

* H. Burmeister, 'Die Labyrinthodonten aus dem bunten Sandstein von Bernburg,' pt. i. (1849). The minute posterior pterygoid teeth are seen in a specimen of *Trematosaurus* in the British Museum (no. R. 1733) and in one in Mr. W. E. Balston's collection.

It may be added that vertebrae, ribs, and other fragmentary fossils from the Trias of Spitzbergen have already been referred to Labyrinthodonts* ; but the specimens described are scarcely sufficient for exact determination.

EXPLANATION OF THE PLATES.

PLATE XI.

Capitosaurus stantoneus, sp. nov. (p. 170) ; from Lower Keuper, quarries of Messrs. Peter Ford and Sons, Stanton, near Uttoxeter. [Brit. Mus. no. R. 3174.]

Fig. 1. Upper view of skull, two-thirds nat. size.

2. Occiput of the same, two-thirds nat. size.

PLATE XII.

Aphancramma rostratum, gen. et sp. nov. (p. 173) ; from Trias, Sticky Keep, Spitzbergen. [Brit. Mus. nos. R. 3180-82.]

Fig. 1. Upper view of imperfect hinder half of skull, internal mould, one-half nat. size.

2. Left side view of the same, one-half nat. size.

3. Hinder view of quadrate region of the same, one-half nat. size.

4. Ornament of part of cheek of the same, showing slime-canal, one-half nat. size.

5. Bases of teeth on maxilla and pterygoid of the same, nat. size.

6. Upper view of end of snout, internal mould, one-half nat. size.

7. Palatal view of the same, one-half nat. size.

8, 9. Imperfect vertebral centra, one-half nat. size.

LETTERING :—*au.*, opening for auditory meatus ; *bocc.*, supposed basioccipital ; *c.*, occipital condyle ; *ep.*, epiotic ; *ex.*, exoccipital ; *fm.*, foramen magnum ; *fr.*, frontal ; *j.*, jugal ; *la.*, lachrymal ; *mx.*, maxilla ; *na.*, nasal ; *op.*, opisthotic ; *orb.*, orbit ; *pa.*, parietal ; *pas.*, parasphenoid ; *pin.*, pineal foramen ; *pl.*, palatine ; *pmx.*, premaxilla ; *prf.*, prefrontal ; *psq.*, prosquamosal ; *pt.*, pterygoid ; *ptf.*, postfrontal ; *ptn.*, posterior nares ; *pto.*, postorbital ; *ptv.*, postero-temporal vacuity ; *pv.*, premaxillary vacuity ; *qj.*, quadrato-jugal ; *qu.*, quadrate ; *socc.*, space for supraoccipital ; *sq.*, squamosal ; *st.*, supratemporal ; *v.*, vomer.

* N. Yakowlew, "Neue Funde von Trias-Sauriern auf Spitzbergen," Verhandl. russ.-k. min. Ges. vol. xl. (1902), p. 180, pl. iii. ; "Nachtrag," *loc. cit.* vol. xli. (1904), pp. 165-169.

November 15, 1904.

Dr. W. T. BLANFORD, C.I.E., F.R.S., Vice-President,
in the Chair.

The Secretary read the following reports on the additions made to the Society's Menagerie during the months of June, July, August, September, and October, 1904:—

The number of registered additions to the Society's Menagerie during the month of June was 149, of which 44 were acquired by presentation, 20 by birth, 15 by purchase, 69 were received on deposit and 1 in exchange. The number of departures during the same period, by death and removals, was 121.

Among the additions special attention may be called to:—

1. A male Buffon's Kob (*Kobus kob*), new to the Collection, received on deposit on June 2nd.
2. A male Goral Antelope (*Nemorhædus goral*), presented by Major Rodon, F.Z.S., on June 3rd.
3. A male Chimpanzee (*Anthropopithecus troglodytes*), from the Congo, purchased on June 5th.
4. A male Speke's Antelope (*Tragelaphus spekii*), new to the Collection, received on deposit on June 27th.
5. Two Ural Owls (*Syrnium uralense*), received on deposit on June 29th.

The number of registered additions to the Society's Menagerie during the month of July was 181, of which 74 were acquired by presentation and 22 by purchase, 63 were received on deposit, and 22 were bred in the Menagerie. The number of departures during the same period, by death and removals, was 162.

Among the additions special attention may be called to:—

1. A Rüppell's Colobus (*Colobus abyssinicus*), deposited on July 2nd.
2. Two Japanese Bears (*Ursus japonicus*), one presented by Miss Violet M. Lakin on July 11th, and the other deposited on July 28th.
3. A male Sing Sing Waterbuck (*Kobus unctuosus*); 4. A male Gambian Ourebi (*Ourebia nigricaudata*); 5. A male Ostrich (*Struthio camelus*); and 6. Three Levaillant's Parrots (*Pseocephalus robustus*): presented by Capt. Sir George Denton, K.C.M.G., F.Z.S., on July 14th.
7. Two young male Greater Koodoos (*Strepsiceros kudu*), deposited on July 15th.
8. A Yellow-crowned Penguin (*Eudyptes antipodum*), and 9. Two Rock-hopper Penguins (*Eudyptes chrysocome*), purchased on July 23rd.

The number of registered additions to the Society's Menagerie during the month of August was 270. Of these 70 were acquired

by presentation and 28 by purchase, 87 were born in the Gardens, and 85 were received on deposit. The number of departures during the same period, by death and removals, was 182.

Among the additions special attention may be called to :—

1. A female Lar Gibbon (*Hylobates lar*), presented by Mr. C. R. Stokoe on August 9th.
2. A Capybara (*Hydrochoerus capybara*), presented by Messrs. the Liebig Extract of Meat Co. on August 18th.
3. Two young female Gorillas (*Anthropopithecus gorilla*), obtained by purchase on August 19th.

The number of registered additions to the Society's Menagerie during the month of September was 156, of which 69 were acquired by presentation, 10 by purchase, and 77 were received on deposit. The number of departures during the same period, by death and removals, was 142.

Among the additions special attention may be called to :—

1. A fine specimen of Wolf's Monkey (*Cercopithecus wolfi*), deposited on Sept. 5th. This beautiful species is figured in P. Z. S. 1894, pl. vii.
2. An Aru-Islands' Kangaroo (*Macropus brunii*), deposited Sept. 9th.
3. A pair of Kelp Geese (*Chloëphaga antarctica*), from the Falkland Islands, presented by Mr. Vere Packe, Sept. 14th.

The registered additions to the Society's Menagerie during the month of October were 128 in number. Of these 76 were acquired by presentation and 12 by purchase, 3 were born in the Gardens, 36 were received on deposit and 1 in exchange. The total number of departures during the same period, by death and removals, was 163.

Among the additions special attention may be called to :—

1. Three Beatrix Antelopes (*Oryx leucoryx*), one from Aden, a female, presented by Mr. G. W. Bury on Oct. 5th, and a pair from the Persian Gulf, presented by Major P. Z. Cox, I.S.C., F.Z.S., on Oct. 22nd.
2. Two King Birds of Paradise (*Cicinnurus regius*), from New Guinea, purchased on Oct. 15th. New to the Collection.
3. A new species of Moustache Monkey (*Cercopithecus*, sp. n.), from the Gaboon, deposited on Oct. 15th.
4. A Du Chaillu's Monkey (*Cercopithecus nigripes*), from the Gaboon, deposited on Oct. 15th.
5. Two Schmidt's Monkeys (*Cercopithecus schmidtii*), from the Congo, deposited on Oct. 17th.
6. Two Blue-tailed Fruit-Pigeons (*Carpophaga concinna*), from the Aru Islands, presented by Mrs. Johnstone on Oct. 17th.

Mr. R. Lydekker communicated the result of recent correspondence connected with the sketch by a Chinese artist of a Deer from Hainan purporting to be Père David's Deer (*Elaphurus*

Davidianus), recently exhibited to the Society (Proc. Zool. Soc. 1904, ii. p. 83). When this sketch was exhibited it was understood to have been drawn from a specimen in the possession of Mr. E. T. C. Werner, then British Consul at Hainan, and was thus taken (in spite of the addition by the artist of a pair of Peking-Deer antlers) as evidence of the existence of *Elaphurus davidianus* in Hainan. In a letter dated June 26, Mr. Werner states, however, that the artist drew the sketch from memory after the death of the animal, and also that there was considerable doubt as to whether the latter really was Père David's Deer (Tsū-pu-hsiang) at all. Nevertheless the writer expressed his belief that the species did exist in Hainan. On the other hand, in answer to further enquiries, Mr. Hughes, now Consul at Hainan, wrote that, so far as he could ascertain, Père David's Deer was unknown in Hainan, and that the drawing in question must be regarded as a fancy sketch. Under these circumstances, despite the fact that the sketch undoubtedly portrayed that species, no credence could at present be given to the alleged occurrence of Père David's Deer in Hainan.

Mr. F. E. Beddard, F.R.S., called the attention of the meeting to a fact in the life-history of Kangaroos concerning which but little appeared to be known. An example of *Macropus dorsalis*, which died on the 4th Nov. last, was found to contain a young one in the pouch which had survived the death of the parent. The young kangaroo was 6 inches in length (to the root of the tail) and still perfectly naked. On being removed from the pouch, it moved its limbs vigorously and emitted a sound which was rather more voice-like than a hiss.

It was difficult to describe the nature of the sound accurately. It was uttered at continuous intervals. The production of any sound in so imperfectly formed an animal was remarkable.

Mr. Frederick Gillett, F.Z.S., exhibited some antlers of the Altai Stag (*Cervus eustephanus*), and made the following remarks on their growth based on his own observations in the Society's Gardens:—

“An Altai Stag, purchased by the Society on Aug. 10th, 1897, although in poor condition and not expected to live, in the following year produced three sets of antlers and served two hinds, becoming the parent of a stag and a hind. The young stag shed his first pairs of antlers in a twelvemonth, and I am able to show these antlers to-night. This young stag grew very large, and when two years old bore antlers with twelve points. This stag was then sold to Hagenbeck.

“The stag now in the Gardens shed a set of antlers on May 28th, 1902, having produced two sets in the year before; and the three sets which I exhibit to-night were shed by it on the following dates:—Jan. 6th, 1903; June 10th, 1903; April 23rd, 1904.”

Dr. P. L. Sclater, F.R.S., stated that in July last he had visited Brussels in order to examine the specimens of the Okapi (*Okapia johnstoni*) in the Museum of the Congo Free State at Tervueren near that city. This he had been enabled to do by the kind permission of M. Émile Coart, Conservateur du Musée du Congo. The mounted series of the Okapi in that Museum consisted of a fine adult pair, of which the male carried short giraffe-like horns, as shown in a lithographic plate which was exhibited, while the female had none, and of a pair of skeletons in which the male had likewise horns but the female was hornless. There were also two other mounted specimens of immature animals. Besides these specimens, Dr. Sclater was informed that others had been sent from Tervueren by order of King Leopold to the Museums of Tring, Paris, Stockholm, Madrid, Antwerp, and Rome. All the specimens, as Dr. Sclater understood, had been received from the Station of the Congo Free State on the Ituri, which was practically in the same forest-district as Fort Mbeni, where Sir Harry Johnston's specimens had been obtained, although the Ituri belonged to the water-basin of the Congo, and not to that of the Nile.

Dr. Sclater also called attention to an article "*Aus dem dunkelsten Africa*," published in the 'Basler Nachrichten' for May 22nd last, and subsequently abstracted in 'Globus' of July the 21st last (vol. lxxxvi. p. 61), whereby it appeared that the writer, Dr. T. T. David, a Swiss naturalist resident at Beni on the Semliki, claimed to be the first European who has observed and obtained an Okapi in its native wilds. Dr. David had sent one of his specimens to Prof. R. Burckhardt, C.M.Z.S. (whose former pupil he had been), for the Zoological Museum at Basel, but Prof. Burckhardt had informed Dr. Sclater that it was unfortunately received in a bad condition.

The following was an abstract of Dr. David's principal remarks in the 'Basler Nachrichten':—

"The extremely elongated skull of the Okapi presents small rudiments of horns on the frontal bones. The animal in life has the general bearing of a Tapir; it is certainly a Ruminant, but its whole appearance, its actions in the swamps in which it lives, its compressed body and the way in which it carries its head, remind one of a Tapir and not at all of an Antelope, so that the stuffed examples of this animal in London and Brussels are quite erroneously set up. The striping of the limbs is much brighter than that of the Zebras. The back is red, especially so in the male; the ears are enormously large, and are furnished with great tufts of hairs standing up. Small horns are present in some specimens, and, moreover, in both sexes, but are absent in others, which induces me to believe in the possibility of the existence of two species of Okapi. The underskin is as thick as in the Pachyderms, which makes it a very difficult animal to prepare."

Dr. Sclater concluded by saying that, notwithstanding what Dr. David had stated and the views of Prof. Lankester and Dr. Forsyth Major, he was quite unable to believe in the existence of more than one species of Okapi in the same limited district, though it seemed that the individual specimens presented some unusual modifications.

Mr. W. B. Tegetmeier, F.Z.S., exhibited a specimen of an Asiatic King-Crab (*Carcinoscorpius rotundicauda*) which had been picked up alive off the Isle of Wight.

Prof. J. C. Ewart, F.R.S., exhibited some skins and a series of lantern-slides of the Zebras of East Africa, and read the following note on a form generally resembling in conformation and markings the Mountain Zebra of South Africa:—

Some years ago Mr. Rowland Ward presented me with a stuffed Zebra which, though originally “traded out of Somaliland,” has a general resemblance to the Mountain Zebra of South Africa. This Zebra (now in the Royal Scottish Museum, Edinburgh) is in several respects so unlike the other forms hitherto described that, without waiting for its exact habitat*, it may be worth while pointing out how it agrees with, and differs from, the true Mountain Zebra.

Text-fig. 35

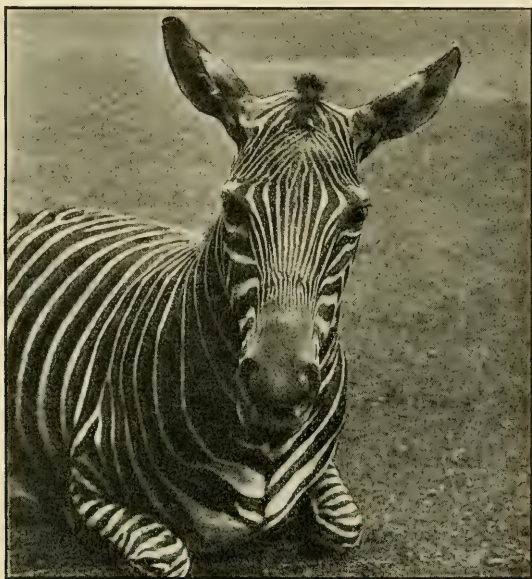


Photo by G. A. Ewart.

Ward's Zebra, to show long ears and face-stripes.

This Zebra (which may be known as Ward's Zebra) very closely resembles the Mountain Zebra in height, in the form and size of the head, ears, and muzzle (text-fig. 35), in the mane,

* It probably inhabits part of the area between the upper reaches of the Tana River and Lake Rudolf.

tail, and hoofs, and in having the stripes over the rump arranged to form the so-called gridiron pattern (text-fig. 36).

It differs from the Mountain Zebra in having a broad dorsal band ($3\frac{1}{4}$ inches wide as it crosses the croup), all the hairs of which are directed backwards—in the Mountain Zebra the dorsal band midway between the withers and the croup is represented by a mere line, while from the croup to the mane the hair is directed forwards, *i. e.* the whorl usually at the end of the mane in the Equidæ is on a level with the croup. The Mountain Zebra differs also from Ward's Zebra (1) in having a dew-lap, (2) in having decidedly larger front chestnuts, (3) in having a larger number of stripes running at right angles to the dorsal band, (4) in having the legs more intensely striped, and (5) in the ground-colour being nearly white; in Ward's Zebra, with the exception of the inner surface of the limbs and under surface of the body, where white prevails, the ground-colour is of a rich cream tint.

Text-fig. 36.



Photo by G. A. Ewart.

Ward's Zebra, to show "gridiron" and broad dorsal band.

In Ward's Zebra the stripes, except in the vicinity of the muzzle, are of a dark brown colour, the muzzle and the nostril-patches are darker than in the Mountain Zebra, and the stripes above the nostril-patches are of a pale brown hue. The face is



H.Grönvold del.et lith.

Mintern Bros. imp.

SCOTONYCTERIS BEDFORDI.

decorated with four pairs of nearly symmetrically arranged stripes, widest apart on a level with the eyes, and with four pairs of stripes which meet in the centre of the forehead at or near the point where the mane terminates four inches below the occipital crest.

In the above-mentioned stripes, as in those on the sides of the head and on the neck, there is close agreement between the two Zebras under consideration, but, as already stated, there are fewer stripes in Ward's Zebra in connection with the dorsal band. If the "gridiron" in the two forms is compared it will be noticed that in Ward's Zebra the bars running across the rump are coarser than in the Mountain Zebra, apparently owing to the obliteration of several of the intervening light spaces.

In text-figure 35 the colour and great length of the ears in Ward's Zebra are well brought out—the ears are longer than in any of the Mountain Zebras I have had the opportunity of measuring, and instead of presenting a white tip and a narrow white band midway between base and apex as in the Mountain Zebra, the apex is dark, while the proximal part is only faintly and irregularly pigmented.

If one may judge by the ears, hoofs, and coloration, Ward's Zebra is adapted for a habitat similar to that of the Mountain Zebra; moreover, like the Mountain Zebra, it has the reputation of being stubborn and intractable.

The following papers were read:—

1. On Mammals from the Island of Fernando Po, collected by Mr. E. Seimund. By OLDFIELD THOMAS, F.R.S., F.Z.S.

[Received July 13, 1904.]

(Plate XIII.*)

[The complete account of the new genera and subspecies described in this communication appears here; but since the names and preliminary diagnoses were published in the 'Abstract,' the genera and subspecies are distinguished by the names being underlined.—EDITOR.]

One of the chief desiderata of the British Museum collection of Mammals has long been a proper series representing the fauna of the Island of Fernando Po. For from this island there came in the early days of the study of zoology by British workers quite a number of specimens, and these were described in the 'Proceedings' of this Society by Mr. G. R. Waterhouse and others. But owing to age and exposure to light at a time when the exhibition of types was not thought criminal, the original specimens, on which all our comparisons depended, have become so faded that but little use can now be made of them.

* For explanation of the Plate, see p. 187.

Attention having been again called to this island by the remarkable ornithological discoveries made there by Capt. Boyd Alexander, a special collecting-trip in the interests of the National Museum was rendered possible by the generosity of our President (the Duke of Bedford), of Mrs. Percy Sladen, and the Hon. Walter Rothschild. A free passage to the island and back was also given to the collector by Messrs. Elder, Dempster & Co., through the kind offices of Sir Alfred Jones.

The collector, Mr. E. Seimund, started in November 1903, arrived in the island on December 4, and left again in April 1904, so that he had in all just over four months in which to collect.

The series he obtained is exceedingly valuable for the reasons above mentioned, as he got good sets of nearly all the species described so long ago by our predecessors in mammalogical research; and these cannot fail to be of constant service to all workers on the subject.

Of novelties I have only had occasion to describe two—*Scoto-nycteris bedfordi*, a Fruit-Bat, and *Galago demidoffi poensis*, a local race of the little West-African Galago; but Mr. Seimund has found on the island several other mammals which had not previously been recorded from there.

Our knowledge of the Mammals of Fernando Po rests chiefly on the following literature:—

WATERHOUSE, G. R.—Descriptions of new Mammals from the Island of Fernando Po, based on specimens presented by George Knapp, Esq. P. Z. S. 1838, p. 57.

Colobus, *Cercopithecus*, *Genetta*, *Lutra*, and *Cephalophus*.

WATERHOUSE, G. R.—Descriptions of new Mammals from Fernando Po, obtained by Mr. L. Fraser during the Niger Expedition. P. Z. S. 1842, p. 124.

Anomalurus and Squirrels.

ALLEN, W., and THOMSON, T. H. R.—Narrative of the Expedition to the River Niger. Appendix, vol. ii. pp. 472 *et seqq.* 1848.

Most of the Mammals obtained on the Expedition were collected at Fernando Po by L. Fraser.

BOCAGE, J. V. BARBOZA DU.—Subsidios para a Fauna da Ilha de Fernão do Pó: Mammíferos. Jorn. Sci. Lisboa, (2) iv. p. 1, 1895.

16 species (none new) collected by Mr. P. Newton.

BOCAGE, J. V. BARBOZA DU.—Faune des Quatre Isles du Golfe de Guinée: Mammifères. Jorn. Sci. Lisboa, (2) vii. p. 25, 1903.

Full list of species.

Descriptions of isolated species have also been published by Gray, Bennett, Ogilby, A. Smith, and others.

The second of Prof. Bocage's two papers gives a full list of the

Mammals of the island, and I have now, by intercalating the additional species obtained by Mr. Seimund and modifying one or two doubtful determinations, drawn up a list of the indigenous species complete to date, with the names of the collectors on whose specimens the species have been determined.

This contains 36 species, as follows:—

1. <i>Colobus pennanti</i> Waterh.	Knapp, Thomson.
2. " <i>satanas</i> Waterh.	Knapp, Thomson, Newton, Seimund.
3. " <i>polycomus</i> Schr.*]	
3. <i>Cercopithecus erythrotis</i> Waterh.	Knapp, Thomson, Fraser, Burton, Seimund.
4. " <i>preussi</i> Matsch.	Seimund.
5. " <i>martini</i> Waterh.	Knapp.
6. " <i>campbelli</i> Waterh.	Thomson.
(<i>burnetti</i> Gray).	
7. " <i>pogonias</i> Benn.	Knapp, Thomson, Fraser.
8. <i>Galago elegantulus</i> Leconte.	Burton, Newton.
9. " <i>alleni</i> Waterh.	Allen, Thomson, Burton.
10. " <i>demidoffi poensis</i> Thos.	Seimund.
11. <i>Hypsignathus monstrosus</i> Allen.	Newton.
12. <i>Rousettus stramineus</i> Geoff.	Newton, Seimund.
13. <i>Scotonycteris bedfordi</i> Thos.	Seimund.
14. <i>Rhinolophus landeri</i> Mart.	Thomson.
15. <i>Hipposiderus fuliginosus</i> Temm.	Fraser, Newton, Seimund.
16. <i>Nycteris hispida</i> Schr.	Fraser, Capt. E. Downes, Seimund.
17. <i>Mimetillus moloneyi</i> Thos.	Seimund.
[<i>Glauconycteris poensis</i> Gray †.]	
18. <i>Nyctinomus brachypterus</i> Peters ‡.	Downes.
19. <i>Crocidura poensis</i> Fraser.	Fraser, Seimund.
20. <i>Sylvisorex johnstoni</i> Dobs.	Seimund.
21. <i>Genetta poensis</i> Waterh.	Knapp.
22. <i>Poiana richardsoni</i> Thos.	Thomson, Seimund.
23. <i>Lutra capensis poensis</i> Waterh.	Knapp.
24. <i>Anomalurus fraseri</i> Waterh.	Fraser, Thomson, Alexander, Newton, Seimund.
25. <i>Sciurus stangeri</i> Waterh.	Fraser, Thomson, Newton, Seimund.
26. " <i>rufobrachiatu</i> s Waterh.	Fraser, Thomson, Seimund.
27. " <i>punctatus</i> Temm.	Newton.
28. <i>Funisciurus erythrogenys</i> Waterh.	Fraser, Thomson, Seimund.
29. " <i>poensis</i> Smith.	Smith, Thomson, Fraser, Alexander, Seimund.
30. <i>Mus tullbergi</i> Thos.	Seimund.
31. " <i>alleni</i> Waterh.	Allen, Seimund.
32. <i>Cricetomys gambianus</i> Waterh.	Smith, Newton, Seimund.
33. <i>Procavia dorsalis</i> Fraser.	Fraser, Alexander, Newton, Seimund.
34. <i>Cephalophus ogilbyi</i> Waterh.	Fraser, Thomas, Alexander, Seimund.
35. " <i>melanorheus</i> Gray.	Thomson, Fraser, Thrupp, Alexander, Seimund.
36. <i>Manis tricuspis</i> Raf.	Fraser, Newton.

1. COLOBUS SATANAS Waterh.

Native skin. Bubi Town, Bantabiri, 500 m.

* There would appear to be some error in the inclusion of *Colobus polycomus* in the Fernando Po fauna. Prof. Bocage puts it in on the authority of Gray, who mentions two of Knapp's skins as belonging to it. But the list of Knapp's specimens given by Waterhouse in 1838 does not include it, and until some confirmation is obtained of its occurrence in the island I think it should be deleted from the list.

† It is stated by Allen and Thomson (*l. c.* p. 480) that the specimen described by Gray as *Kerivoula poensis* was not obtained in Fernando Po, but at Abo on the Niger. It has therefore to be deleted from the island list.

‡ *N. pumilus* Dobs. Cf. de Winton, Ann. Mag. N. H. (7) vii. p. 38 (1901).

2. *CERCOPITHECUS ERYTHROTIS* Waterh.

Cercopithecus erythrotis Waterh. P. Z. S. 1838, p. 59.

♂. 78, 81. ♀. 74. Bubi Town, Bantabiri, 500 m.

♂. 147. ♀. 160. Bantabiri, 1800 m.

Well-known as it is by menagerie specimens, few Museums possess any wild-killed examples of this handsome monkey, and the present specimens are therefore most acceptable. The original types of this monkey, of *C. martini*, and of *Colobus satanas* were native-made skins, presented to the Zoological Society's Museum by Mr. George Knapp in 1838, being the earliest zoological specimens known to have come from Fernando Po.

3. *CERCOPITHECUS PREUSSI* Matschie.

♀ (young). 165. N. Bantabiri, 1800 m.

Two native skins.

Not previously recorded from the island or represented in the British Museum.

Dr. Matschie, during a visit to London, has examined these specimens, and considers them to be the same as the species described by him under the above name. His types came from Victoria, Cameroons, and he tells me that this southern part of the Cameroons has a fauna very like that of Fernando Po, such species as *Colobus satanas*, *Cercopithecus erythrotis*, and others occurring there without modification. The presence of *C. preussi* in Fernando Po is therefore not surprising.

4. *GALAGO DEMIDOFFI POENSIS* Thos.

Galago demidoffi poensis Thos. Abstr. P. Z. S. 1904, No. 10, p. 12, Nov. 22.

♂. 152, 153, 162. ♀. 167. Bantabiri, 1800 m.

"Shot in tree by night."—E. S.

Similar in all essential respects to the true *G. demidoffi* of continental West Africa, but the under surface is paler, whitish instead of buffy. General colour above, of specimens in full pelage, pale russet or cinnamon-brown. Central light line of face white, contrasting more markedly with the general colour than the more or less buffy one of true *demidoffi*. Hairs of under surface slaty for two-thirds their length, then either white or pale buffy yellowish. Outer side of limbs like body, a line along the inner sides pure white; the hairs white to their bases, and forming prominently white patches below the elbows and thighs. The corresponding regions in true *demidoffi* are buffy or yellowish, never pure white. Upper surface of hands and feet dull whitish. Tail dark brown, darkening slightly terminally. Ears apparently rather larger, such measurements as are available running from 27 to 30 mm., as against 24 to 27 mm. in *demidoffi*.

Skull much as in *demidoffi*, though inconspicuously larger.

Dimensions of the type, measured in the flesh:—

Head and body 130 mm.; tail 195; hind foot 46; ear 28.

Skull—greatest length 38·2; greatest breadth 25·5; interorbital breadth 5·4; breadth of brain-case 19·6; front of canine to back of m^3 12·5.

Type. Adult male, no. 152. B.M. No. 4.7.1.8. Killed 6 March, 1904, at an altitude of 1800 metres.

Compared with 15 well-preserved specimens of the Continental form from localities ranging from the Gold Coast to Uganda, the four skins obtained by Mr. Seimund differ so uniformly by the lightness of their under surfaces, and the pure white of the inner aspect of their limbs, that I think they should have a special sub-specific name.

Galago demidoffi has not been previously recorded as occurring in Fernando Po, though a skeleton obtained there was received from Sir Richard Burton in 1862, just after the publication of Gerrard's 'Catalogue of Bones of Mammalia.'

5. ROUSETTUS STRAMINEUS Geoff.

♂. 108, 110, 114, 115, 117, 118, 119, 124, 125. ♀. 111, 112, 113, 116, 120, 121, 122, 123. Bantabiri, 10 m.

♂. 178, 181. ♀. 87, 105, 106, 179, 184. Bantabiri, 10 m.
"Very common."—E.S.

Prof. Bocage also records *Hypsignathus monstrosus* as having been discovered in the island by Mr. Newton.

This fine series of specimens shows a peculiar and very unusual sexual difference in colour which does not seem to have been previously noticed. The males, without exception, are more or less brown, the bright yellowish shoulder-patches contrasting strongly with the general dark colour. The females on the other hand are, both above and below, of the rich yellowish straw-colour so often described as occurring in this species.

For the female of any animal to be more richly coloured than the male is an unusual phenomenon.

6. SCOTONYCTERIS BEDFORDI Thos. (Plate XIII.)

Scotonycteris bedfordi Thos. P. Z. S. 1904, vol. i. p. 372.

♀. 31. Fish Town, 10 m.

"Shot during the daytime, hanging on a tree."—E. S.

This most interesting Bat is the only new species obtained on Mr. Seimund's expedition, and I have thought it worthy of a figure. It is the first member of the genus to be received by the Museum, and is therefore a most welcome accession.

The previously known species, *S. zenkeri* Matsch., was described from the Cameroons.

The external characters of *S. bedfordi* have been already described, but the following measurements of its skull may be of service:—Greatest length 25·4 mm.; basal length 22·6; zygomatic breadth 16·5; interorbital breadth 4·8; breadth of brain-case 11·1; palate length 14; front of canine to back of molar 8·7; front of lower canine to back of m_2 10.

The specific distinction of *S. bedfordi* rests mainly on the

conspicuously smaller size of the ears, these being only 11 mm. in the island species and 17 in *S. zenkeri*. The skulls, judging only by Dr. Matschie's description, seem closely similar.

The cheek-tooth formulæ of *Scotonycteris* and *Epomophorus* are considered by Dr. Matschie to be $P. \frac{1}{2}$, $M. \frac{2}{3}$, and that of *Cynopterus* to be $P. \frac{2}{3}$, $M. \frac{2}{3}$; but the study of a young specimen of the last-named genus shows that Dobson was perfectly right in giving its formula as $P. \frac{3}{3}$, $M. \frac{1}{2}$ *. This young specimen has milk-premolars present above the second and third cheek-teeth in each jaw, thus showing them both to be premolars; the minute anterior tooth has, as usual, no predecessor.

It would follow from this that the formula in *Scotonycteris* is $P. \frac{2}{3}$, $M. \frac{1}{2}$, the same as that rightly determined for *Epomophorus* by Dobson.

But further, while correctly determining the teeth of *Cynopterus*, Dobson does not seem to have realized that the same formula, $P. \frac{3}{3}$, $M. \frac{1}{2}$, would certainly be applicable to *Nyctymene* † ("*Harpyia*"), to which he assigns $P. \frac{2}{3}$, $M. \frac{2}{3}$.

In *Dobsonia*, on the other hand, with the same total number of four cheek-teeth in the upper jaw, the tooth lost has obviously been the anterior premolar instead of the last molar, so that the formula should be, as Dobson puts it, $P. \frac{2}{3}$, $M. \frac{2}{3}$. Matschie erroneously gives it as $P. \frac{2}{2}$, $M. \frac{2}{3}$.

7. HIPPOSIDERUS FULIGINOSUS Temm.

♂. 61, 62. ♀. 57, 63, 100. Bantabiri, 10 m.

♀. 19. Fish Town, 10 m.

♂. 52. Sepopo, 10 m.

♂. 54. Taka, 10 m.

"Very common."—E. S.

One of these specimens, a female, is bright orange, the others are of the usual dark sooty brown.

8. NYCTERIS HISPIDA Schr. (?).

♂. 72. Bubi Town, Bantabiri, 500 m.

Not satisfactorily determinable in the dried condition.

9. MIMETILLUS MOLONEYI Thos.

♂. 183. ♀. 93, 99, 182. Bantabiri, 10 m.

"Shot on the wing. Flight swift and with many rapid turns and twists."

MIMETILLUS Thos.

Mimetillus Thos. Abstr. P. Z. S. 1904, No. 10, p. 12, Nov. 22.

Type. *Vesperugo* (*Vesperus*) *moloneyi* Thos. Ann. Mag. N. H. (6) vii. p. 528 (1891).

* In the account of the genus Cat. Chir. B. M. p. 80; but in the synopsis of the genera on p. 3 the formula is given by an oversight as $P. \frac{2}{3}$, $M. \frac{2}{3}$.

† Cf. P. Biol. Soc. Wash. xv. p. 198 (1902), where, however, the name is accidentally misprinted *Nyctimene*.

Distinguished from *Vespertilio* (= *Vesperus*) by the abnormal reduction in the size of the wings, which look insufficient to support so large and heavy a body, and by the remarkable breadth and flatness of the skull, which resembles in these respects that of *Tylonycteris*.

Further study convinces me that this curious Bat, which I described from a specimen sent home from Lagos by Sir A. Moloney, should be separated generically from *Vespertilio*. Its proportions are quite different from those of any other Bat, as is shown by the fact that its forearm is barely half the length of the head and body, its fifth finger barely longer than even this short forearm, and its third finger is only as much longer than the forearm as the fifth usually is. The result is that the development of the wings recalls that in foetal specimens. The hind limbs are also abnormally short.

In the original description the wing-membranes were said to be uniformly brown, but this is a mistake due to the bad condition of the type. Inward of the fifth finger they are brown, but those between the third and fourth and fourth and fifth digits are a transparent whitish, with a few brown spots terminally.

The penis is remarkable in that it has no reversible prepuce, the uncovered glans being long, conical, and covered with minute reversed setæ.

The skull, although larger, recalls that of *Tylonycteris pachypus* by its broad and peculiarly flattened shape. It is not quite so flat, but its anterior portion is even broader in proportion, the anteorbital projections being unusually developed. Sagittal crest practically absent, lambdoid crests strong. No distinct occipital "helmet." Median palatal spine longer.

Owing to its short velvety-brown fur and peculiar proportions, this Bat has a strong superficial resemblance to a *Nyctinomus* or *Molossus* rather than to a member of the *Vespertilionidæ*. Hence the generic name suggested for it.

10. *CROCIDURA* (CROC.) POENSIS Fraser.

Crocidura poensis Fraser, P. Z. S. 1842, p. 200; Allen & Thomson, Expedition to River Niger, ii. p. 481 (1848).

♂. 36. ♀. 92. Bantabiri, 10 m.

♂. 26. Fish Town, 10 m.

♀. 140. Bilelipi, 500 m.

This Shrew seems to be the same as that afterwards described from Old Calabar by A. Murray, under the name of *Rhinomys soricoides*, apparently in the belief that it was a rodent. His type specimen, much discoloured, is still in the British Museum.

11. *SYLVISOREX* JOHNSTONI Dobs.

♂. 94. ♀. 68, 103. Bantabiri, 10 m.

A separate skull (67).

SYLVISOREX THOS.

Sylvisorex Thos. Abstr. P. Z. S. 1904, No. 10, p. 12, Nov. 22.

Type. *Crocidura morio* Gray.

African Shrews with white teeth, four upper unicuspid, normal mandibular dentition, and a short-haired tail without the long bristle-hairs characteristic of *Crocidura*.

In 1887* Dr. G. E. Dobson, when describing from the Cameroons the pigmy Shrew now found by Mr. Seimund in Fernando Po, included it together with Gray's *Crocidura morio* in the genus *Myosorex*, a genus founded for the South-African *Sorex varius* Smuts. The latter animal, however, is remarkable for the possession of a minute extra tooth in the lower jaw, as discovered and described by Dobson; and this character I think of such importance as to necessitate the species which do not possess it, but are in other respects allied to *Myosorex*, having a special generic name. This new genus would include the species *S. morio* Gray (type), *S. johnstoni* Dobs., *S. sorella* Thos., and *S. muricauda* Mill.

The four Fernando Po skulls of *S. johnstoni* differ considerably in the relative proportions of the upper unicuspid, the second being much smaller than the third in some cases, as it is in the type, while in others it is nearly as large. I am inclined to believe that in the Soricidæ generally the systematic importance of the relative sizes of these teeth has been considerably over-estimated.

12. POIANA RICHARDSONI Gray.

Native skin. Bantabiri, 500 m.

13. ANOMALURUS FRASERI Waterh.

♂. 58. ♀. 59, 185. Bantabiri, 10 m.

♂. 159. N. Bantabiri, 1800 m.

Although several Fernando Po specimens of *A. fraseri*, including the type, are in the British Museum, all are very much faded by exposure to light, and these fresh topotypes are therefore of much value.

Among the specimens assigned to this species from the mainland of Africa are two from the Lower Niger, which a comparison with Mr. Seimund's examples shows to be subspecifically separable, as follows:—

ANOMALURUS FRASERI NIGRENSIS.

Anomalurus fraseri nigrensis Thos. Abstr. P. Z. S. 1904, No. 10, p. 12, Nov. 22.

Closely similar to the true *fraseri* in all respects, but the general colour paler and greyer—body broccoli-brown, membranes smoke-grey,—and the size, as shown by the skull and teeth, decidedly smaller. The tail also less bushy.

* P. Z. S. 1887, p. 575.

Coloration of head, under surface, and limbs as in true *fraseri*.

Skull smaller and with rather a shorter narrower muzzle than in *fraseri*, the length of the tooth-row decidedly less.

Approximate dimensions of the type, measured in skin:—

Head and body 330 mm.; tail 235; hind foot (s. u.) 57.

Skull—tip of nasals to back of parietals 53 mm.; zygomatic breadth 38; nasals, length 14·7, greatest breadth anteriorly 7·4; interorbital breadth 16; breadth of brain-case 26; palate length from henselion 22·5; diastema 12·5; palatal foramina 6; length of upper cheek-tooth series 11·9; lower jaw, incisor-tip to condyle 37; length of lower tooth-row 13·8.

Hab. Abutschi, Lower Niger.

Type. B.M. No. 2.11.10.5. Collected February 1902 by Mr. A. Braham. Two specimens, adult and immature.

Du Chaillu's *Anomalurus beldeni*, from the Gaboon*, considered by Gray and Alston to be a synonym of *A. fraseri*, appears to me to be referable rather to the red-backed species commonly known as *A. erythronotus* M.-Edw. Considering how widely different in colour the two species are, it seems curious that there should have been any doubt on the subject; but Du Chaillu's description is extremely vague, and it is only from his statement that "on the back the hair is tipped with bright rufous, which gives a rufous tinge from behind the ears to the lower third of the body on the median portion to the commencement of the membranes," that I am able to express an opinion on the matter. This sentence, however, exactly expresses the dorsal coloration of *A. erythronotus*, and the locality is approximately the same, while no examples of *A. fraseri* have been since recorded from the district.

If I am right in this identification, the name *A. beldeni* will have to stand for the red-backed species, as it antedates *A. erythronotus* by many years.

14. SCIURUS STANGERI Waterh.

♂. 17. ♀. 35. Fish Town, 10 m.

♂. 73, 80. Bubi Town, Bantabiri, 500 m.

♀. 95. Bantabiri, 10 m.

♂. 166, 168, 173, 177. ♀. 161, 170, 172, 175. N. Bantabiri, 1800 m.

♂. 126. Bilelipi, 10 m.

15. SCIURUS RUFOBACHIATUS Waterh.

♂. 13, 24, 25, 34, 37, 47. ♀. 18, 21, 22, 23, 32, 33. Fish Town, 10 m.

♂. 3, 4, 6, 10, 39. ♀. 7, 11, 40, 41, 42. Santa Isabel, 10 m.

♂. 77, 82, 97, 143, 144, 163, 171, 176, 177. ♀. 69, 89, 169. Bantabiri, 500 m.

♂. 54, 139. ♀. 134, 137. Clarence Mountain, 1800 m.

* P. Bost. Soc. N. H. vii. p. 303 (1861).

16. FUNISCIURUS ERYTHROGENYS Waterh.

♂. 29. ♀. 14, 16, 20, 38, 43, 50. Fish Town, 10 m.

♂. 51. ♀. 52. Lepopo Beach, 10 m.

♀. 142. Bilelipi, 500 m.

♂. 146. N. Bantabiri, 1800 m.

The last three species of Squirrel were all described, together with *Anomalurus fraseri*, by Mr. G. R. Waterhouse in the 'Proceedings' of the Society for 1842, but during the long interval since no further Fernando Po specimens of these have been received. *S. stangeri* and *S. rufobrachiatus* have proved to be represented on the opposite mainland by forms not specifically distinguishable from those of the island, while, on the other hand, nothing to match *F. erythrogeus* has been found elsewhere.

17. FUNISCIURUS POENSIS Smith.

♂. 31. ♀. 27, 44. Fish Town, 10 m.

♂. 1, 2, 8. Santa Isabel, 10 m.

18. MUS RATTUS L.

♂. Bantabiri, 10 m.

19. MUS TULLBERGI Thos.

♀. 64, 84, 91. Bantabiri, 10 m.

♂. 35, 55. Saka, 10 m.

♀. 136. Clarence Mountain, 1800 m.

20. MUS ALLENI Waterh.

♀. 101. Bantabiri, 10 m.

21. CRICETOMYS GAMBIANUS Waterh.

♂. 56, 77, 83, 85, 90, 102, 110. ♀. 70, 98. Bantabiri, 10 m.

♂. 129. Clarence Mountain, 1800 m.

22. PROCAVIA DORSALIS Fraser.

♂. 156, 158, 158 bis. ♀. 71. N. Bantabiri, 1800 m.

♂. 127, 128. Bubi Town, Bilelipi, 500 m.

♀. 133. Clarence Mountain, 1800 m.

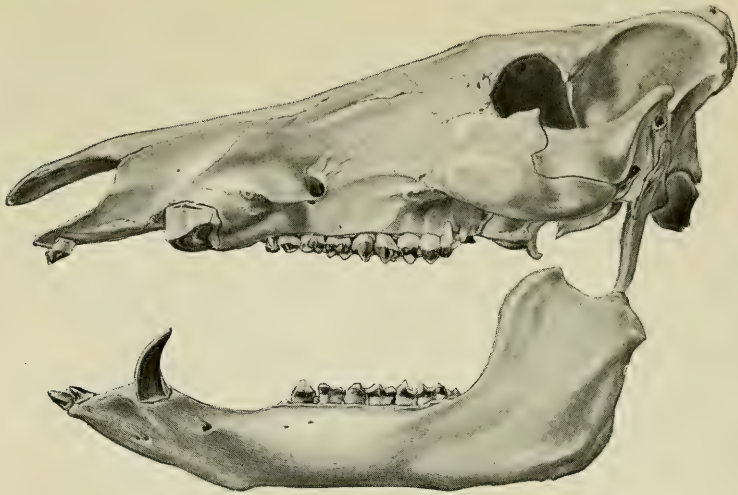
23. CEPHALOPHUS OGILBYI Waterh.

♂. 75. Bubi Town, Bantabiri, 500 m.

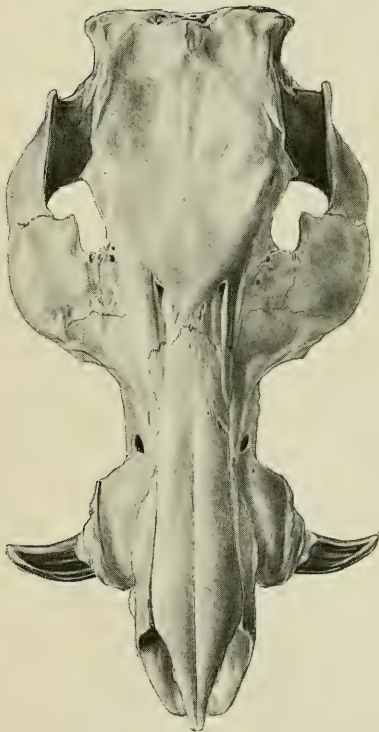
♀. 151. N. Bantabiri, 1800 m.

Besides the type and other specimens obtained in the days of Fraser, the Museum possesses a fine female example of this species, presented by Capt. Boyd Alexander, who shot it at Moka in 1902. It was by the examination of this specimen that I was enabled to distinguish the Fanti *C. brookei* from the present species*.

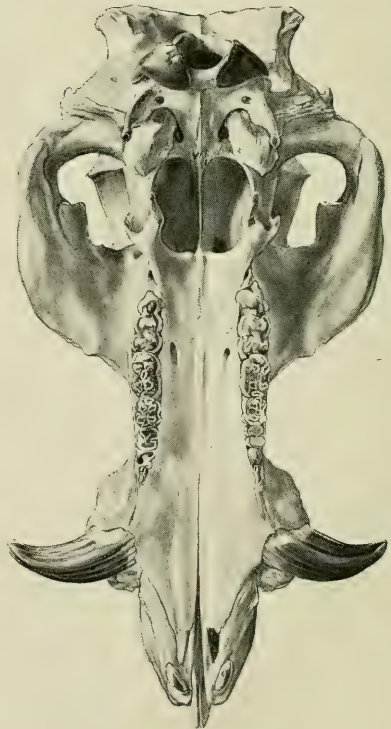
* Ann. Mag. N. H. (7) xi, p. 289 (1903).



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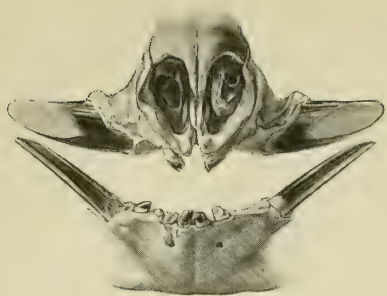
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Engel Terzi, del.

Bale & Danielsson, Lith. Sc.

HYLOCHÆRUS

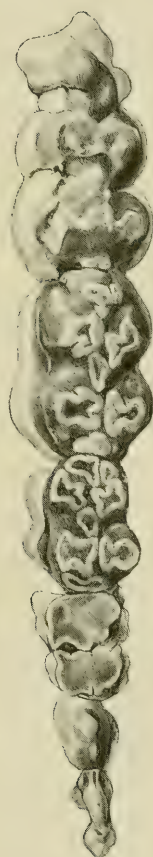
MEINERTZHAGENI.



1



2



3



4



5

24. CEPHALOPHUS MELANORHEUS Gray.

♂.

♀ juv. 109. Bilelipi, 10 m.

♂. 149, 155, 157, 164. ♀. 150, 154. N. Bantabiri, 1800 m.

♂. 76. ♀. 145. Bubi Town, Bantabiri, 500 m.

♀. 60, 66. Bantabiri, 10 m.

EXPLANATION OF PLATE XIII.

Scotonycteris bedfordi, p. 187.2. On *Hylochaerus*, the Forest-Pig of Central Africa.

By OLDFIELD THOMAS, F.R.S., F.Z.S.

[Received October 13, 1904.]

(Plates XIV. & XV.*)

For some years, dating from the discovery of the Okapi, it has been known to zoologists that the natives of the Semliki and other Central African forests had stories to tell about a large pig-like animal, of whose size and ferocity they gave rather highly-coloured accounts. Such stories were first brought to Sir H. Stanley † during his Emin relief expedition of 1888–90, and later on to Sir Harry Johnston ‡ (who thought they might possibly refer to a Pigmy Hippopotamus), to Mr. F. J. Jackson, Mr. W. D. Doggett, and others.

More recently Lieut. R. Meinertzhagen, of the East-African Rifles, hearing tales of this Forest-Pig, determined to secure specimens of it for our National Museum, and it is to his perseverance and generosity that we are indebted for the specimens which form the subject of the present paper.

The following extracts from Lieut. Meinertzhagen's letters to Prof. Ray Lankester will show under what circumstances he obtained the specimens here described:—

“I was on an expedition near Mount Kenya last February and one of my men, who had been tracking cattle in the bambóos about 8000 ft.), reported having killed in the forest a large animal which he greatly exaggerated as to size. I sent him back next day to see if he could bring in any of the beast. He found that the Wanderobo had got one and had cut the animal up. He, however, brought back two pieces of skin §, which was undoubtedly pig-skin, but of no pig with which I was acquainted. The Masai know the animal well and call it ‘Elguia.’ On moving

* For explanation of the Plates, see p. 199.

† Cf. Johnston, in Cornish's ‘Living Animals of the World,’ i. p. 267 (1902).

‡ P. Z. S. 1904, i. p. 228.

§ “It was a sow, as the natives had left 2 fetuses.”

round the south-eastern slopes of Mount Kenya I found the nearly complete body-skin (quite fresh), but cut into four pieces, in a village, and also a large piece of old skin. These formed my first consignment to England.

"In the following May I was in the Nandi country (E.N.E. of the Victoria Nyanza), and in the forest I then again heard of this pig from the natives. Some American missionaries had also heard of it and had even seen examples. One of their men had killed one, and I was able to get a skull and another piece of skin which is identical with the pieces I got from Kenya. I eventually got a portion of another skull from the same locality (c. 7000 ft.). The natives all assert that the Pig is essentially a forest animal and seldom comes into the open, which probably accounts for it not having been brought to the notice of sportsmen before."

I am also able to add the following extract from a letter written by Mr. C. W. Hobley, C.M.G., Sub-Commissioner of the Uganda Protectorate, to Dr. Chalmers Mitchell:—

"I heard of the existence of the Forest-Pig '*Hylochaerus meinertzhageni*' (as being a separate animal from the Wart-Hog or Bush-Pig) from the Wanderobo hunting-tribe about a year ago, and since then have as often as opportunity offered made efforts to obtain the skin and skull of one. I promised a present of a cow to anyone who brought me a complete skin and skull. All I succeeded, however, in obtaining was a shield made of the skin of this animal. Quite a number of shields made of the hide of this pig are to be found in E. Kakumega and Tiriki, and some years ago I noticed these shields and inquired from what animal they were derived; my informant, however, misled me by telling me it was the hide of the 'Aard-vark' or Ant-Bear, and it was only about six months ago that I discovered my error.

"The Forest-Pig is, I find, well known by the Nandi, Masai, and Wanderobo. The Masai equivalent is 'El Guya'; the Nandi equivalent is 'Tūmtu' (which, I believe, means *forest-dweller*); the Kakumega and Tiriki equivalent is 'Mbirri'; some Wanderobo call it 'Tūm'; there is, however, another word which I have for the moment mislaid.

"All the various tribes acquainted with the beast are united about its size; the Wanderobo assured me it was as large as a zebra, and the Kakumega people, who do not know the zebra, said it was as large as a small ox. These two comparisons agree very well.

"The only skulls I have seen are those which Lieut. Meinertzhagen obtained from the forest between Tiriki and Kabwaren, and one which Mr. R. J. Church, of the Uganda Railway (now resident at Nairobi), had obtained on Mau about two years ago. I have not had an opportunity of comparing the latter with Lieut. Meinertzhagen's specimens, but believe it to be the same; Mr. Church had a head-skin of his specimen, and I believe it had a lot of white

hair on the face. Mr. F. J. Jackson also saw Mr. Church's specimen, and may be able to verify this.

"The natives of Western Nandi, in the vicinity of the forest from which Lieut. Meinertzhagen obtained his specimens, tell me that before the great rinderpest plague of 1891 these animals were numerous in the forests of W. Nandi, but the plague killed nearly all; they spoke of its fierceness, and said it occasionally attacked women who went into the forest to gather firewood.

"With regard to the distribution of the animal, I have heard of it being found in the Leikipia forest, the Subugo Leldian on the E. side of the Rift valley, in the Kakumega forest, in the Mau forest near Elgeyo, and I believe it will be found in the Elgon forests."

The specimens obtained by Lieut. Meinertzhagen consist of (1) the imperfect skin, without skull, of a female from Mount Kenya; (2) a perfect skull, with a piece of body-skin, of a young adult male from Nandi, near the Victoria Nyanza, altitude 7000 ft.; and (3) an imperfect skull, without lower jaw, of an old specimen from the last-named place. Specimen 2*, as being a perfect skull, with a piece of skin, would naturally be selected as the type of the species.

The first question that presents itself to every naturalist in connection with such a form is as to whether the animal is most nearly related to the ordinary Pigs, *Sus* and its African representative *Potamochoerus*, or to the aberrant and highly specialised Wart-Hog, *Phacochoerus*, hitherto separated by a wide gap † from every other member of the family.

On a first superficial glance at the skull the answer to this question would be that the new form was allied to *Sus* or *Potamochoerus*, and had nothing to do with *Phacochoerus*, but further study of the cranial and dental characters gradually entirely removes such an impression, and indicates that the animal is a link connecting the two groups, with an undeniable and perhaps ancestral relationship to *Phacochoerus*. It would, in fact, appear to be a survivor of an intermediate stage in the specialisation of the Wart-Hog, its reduced incisors, enlarged upper canines, complicated molars ‡, and basisphenoid pits all showing a relationship to that animal, although neither the canines nor molars are so far advanced in their specialisation. On the other hand, the general proportions of the skull and teeth are more as

* B.M. no. 4.11.5.14.

† Gray and, following him, Flower recognised a special family, the Phacochoeridae, for the Wart-Hogs, but no other writers have done so, and the present discovery confirms the judgment of those who included all the Old-World pigs in the Suidae.

‡ Attention may be drawn here to the figures and description of a fossil Algerian pig said to show some relationship to the Wart-Hog, *Sus phacochoeroides* P. Thomas, Mém. Soc. Géol. France, (3) iii. art. ii. p. 10, pl. iv. figs. 1 & 2 (1884). It is, however, clearly different from the animal now described. For this reference, and much other assistance in connection with the present paper, I am indebted to Dr. Forsyth Major, whose intimate knowledge of the group has been freely placed at my service.

in *Sus* and *Potamochoerus*, while the formation of the parietal region and the characters of the last upper premolar are peculiar to itself. Of ordinary pigs it shows no special affinity whatever with its geographical ally *Potamochoerus*, for it has neither the characteristic rugosity of the muzzle, the specialised lower canine section, nor the simple basisphenoid of that genus. In these latter respects it agrees more with the *Sus verrucosus* group and with the *Babirussa*, but even with them the agreement seems to be rather in the common retention of primitive characters than any real near relationship.

With regard to geographical distribution, I have little doubt that this animal will be found to occur not only in the East-African forests already mentioned, but throughout the great Congo forest, just as *Boocercus* does; and Mr. G. L. Bates, the well-known West-African collector, even tells me that as far west as the upper waters of the Ja River, French Congo, the natives speak of a large black forest-pig, which can hardly be anything else but the present form.

Its habitat being therefore so typically a forest one, I have proposed to call the genus *Hylochoerus*, while the species is termed *meinertzhageni* (cf. 'Nature,' vol. lxx. p. 577, 1904), in honour of the sportsman to whose efforts and generosity the National Museum owes this interesting and important accession.

The following is a more detailed description of the specimens before me:—

Body covered thickly and uniformly with black bristles about 3–8 inches in length, oval in section, about 0·4 mm. in the greater and 0·3 mm. in the lesser diameter. Chest and groins with a certain number of whitish hairs. No evidence as to the existence of a mane, nor are the ears or tail preserved in either of the specimens.

The skull, as may be seen by the accompanying figures (Pls. XIV. and XV.), has the general proportions of that of *Sus* or *Potamochoerus*, not the very peculiar ones found in *Phacochoerus*. The crown is very broad, concave above, parallel-sided, the breadth between the intertemporal fossæ approximately equalling that between the orbits, a state of things very different from that found in any other recent pig*. Occipital surface broader and lower than in other genera, concave, its median line with a sharply defined raised ridge running from the top of the foramen magnum to the centre of the occipital crest; no such ridge is present in other genera. Sides of nasal region sloping smoothly outwards, as in *Phacochoerus*, without any tendency towards the sharpened and, in old animals, rugose edge characteristic of *Potamochoerus*, though it should be remembered that the only specimen showing this part is rather immature. Socket of canines with a prominent longitudinal crest above, probably much more heavily developed in old age. Zygomata broad and heavy, thickened and strongly convex

* In the Pikermi *Sus erymanthius*, however, the proportions of the crown are singularly like those of *Hylochoerus*, widely as it differs in every other respect.

in front of and external to the orbits, this being one of the few characters in which *Hylochoerus* shows more resemblance to *Potamochoerus* than to *Sus*; but even here it is to be noticed that the spring of the zygomata has not the remarkable abruptness found in *Potamochoerus*, and that *Phacochoerus* has a still more prominent zygomatic boss outside and below the eye. Base of skull with two large sharply defined sphenoid pits, separated from each other by the high knife-like vomer, the whole structure being very like the arrangement generally found in *Phacochoerus*, though there is considerable variation in this respect between different specimens of the latter animal. The two skulls of *Hylochoerus* also differ from each other, as the pits are more deeply hollowed out and sharply defined behind in the type than in the older skull. Such pits, present to their full extent in *Phacochoerus*, are also found, though smaller, in *Babirussa*, one of the most primitive of pigs. There is no trace of them in *Potamochoerus* nor in typical *Sus* as represented by the *Sus scrofa* group; but in the peculiar *Sus verrucosus* group there is an indication of a hollowing out in the same region, and in one specimen of *S. verrucosus amboinensis* Major there is a deep pit in the pterygoid on each side of the vomer—evidently a remnant of the same structure. But this pit is absent in another specimen of the same form. Bullæ reaching up rather more than halfway towards the hamular processes, thus intermediate between the low bullæ of *Phacochoerus* and those of *Potamochoerus*, which attain the level of the hamular processes.

Lower jaw posteriorly about as in *Potamochoerus*, not elongated upwards as in *Phacochoerus*, but anteriorly it is broad and spatulate as in the latter genus, in order to accommodate the widely splayed canines.

Dentition.—The permanent incisors, as in *Phacochoerus*, are one in number above on each side and two below, i^2 and i^3 above and i_3 below (all present in *Sus* and *Potamochoerus*) having been lost. But they are larger than in the Wart-Hog, and are probably never shed, as so commonly happens in old individuals of *Phacochoerus*. Moreover, on one side of the single mandible available, the milk-predecessor of i_3 is still in place, the retention of the milk-tooth when the permanent one has been aborted being an intermediate stage between the complete set of *Sus* and the reduced one of *Phacochoerus*. Young examples of this latter do not show any trace of a milk i_3 .

The canines present several characters of interest, and are in many ways of an annectant nature. The upper ones are conical, very thick and heavy basally, indeed as much so as in *Phacochoerus*, but they taper more rapidly, and in the example before me do not much exceed in length those of ordinary swine. The reason of the comparative shortness of the upper canines of *Sus* is that they are so placed that the friction with the lower canines cuts them obliquely across, the lines of the hinder edge of the upper and front edge of the lower pair, when viewed from above,

meeting each other at a sharp angle, so that no part of the upper tooth clears the face of the lower one. On the other hand, the line of the teeth in *Phacochærus* is such as to carry the ends of the upper pair quite clear of the lower ones. Now in *Hylochèrus* we find an intermediate condition of set and curvature, and consequently the upper teeth project a little beyond the ends of the lower ones, without being so conspicuously developed as in *Phacochærus*.

The lower canines are as widely splayed as in *Phacochærus*, or even slightly more so, the angle that the line of one makes with that of the other, when viewed from the front, considerably exceeding a right angle, this angle slightly exceeding a right angle in *Phacochærus*, and falling considerably short of one in all other pigs. In section the lower canines are of the more primitive shape found in the *Sus verrucosus* group, the outer face being nearly equal to the inner, the hinder face being nearly transverse and passing into the wearing surface without noticeable angle. [In *Potamochèrus* and the *Sus scrofa* group the outer face is much narrower than the inner one, and the posterior face is directed obliquely outwards and is at a conspicuously different angle to the surface worn against the upper canine.] Both outer and inner faces have a median longitudinal ridge, really slight but appearing conspicuous owing to its being worn white as compared with the general black colour of the tooth; speaking strictly, therefore, owing to these median ridges, the section of each canine is not a triangle but a pentagon.

The premolars appear at first sight to be three in number above, as in ordinary swine, but closer examination shows the remarkable fact that in both specimens the true last premolar (p^4) has been entirely suppressed, the tooth standing in its place being—in the old as well as in the immature specimen—its milk-predecessor (mp^4). This latter tooth is very similar in shape to the mp^4 of *Phacochærus*, in which animal, however, the normal tooth-change takes place. But in the lower jaw, curiously enough, mp_4 has fallen as is usual, and is replaced by p_4 .

This suppression of p^4 is a most peculiar character, but occurring in two specimens it does not seem permissible to suppose it is only an abnormality, a point that in any case future material will decide. Should it prove a normal character of the animal, it would indicate that in this one respect *Hylochèrus* has gone further in the suppression of its anterior cheek-teeth than even *Phacochærus*.

Below (one specimen only) there is but one premolar present, p_5 , an unusually simple tooth, without secondary cusps of any sort. In front of it there are the roots of some additional premolars, but it is not possible to say how many of them have ever been developed, and for this we must await the advent of younger specimens.

The molars, above and below, are neither of the complicated bunodont structure of those of *Sus* and *Potamochèrus* on the one

hand, nor of the specialised hypsodont nature of those of *Phacochoerus* on the other, but at least it may be said that they present a basis out of which the latter might have been formed. Their structure will be better seen by the figures than by a detailed description, though attention may be drawn to the resemblance of m^2 to that of *Phacochoerus*, and to the development of the median secondary cusps of the lower teeth, these having each its obvious homologue in the complicated hypsodont molars of the derivative form.

The measurements of the typical skull are as follows (the older imperfect skull is only infinitesimally larger, so that the type has evidently reached its full size):—

Greatest median length above 415 mm.; basal length 355; zygomatic breadth 213; nasals, length 235, breadth 52; inter-orbital breadth 95; tip to tip of postorbital processes 124; inter-temporal breadth 92; breadth across lateral occipital protuberances 116; height from basion to top of occipital crest 123; least breadth of maxillary zygomatic processes 57; breadth across sockets of canines 130; breadth between tips of canines 217; palate length 252; least palatal breadth (between m^2) 44; basal diameter of canine (c.) 34; horizontal length of p^2 9, p^3 12·5, mp^1 14, m^1 18·5, m^2 26, m^3 38.

Lower jaw—length (bone only) 320; breadth across symphysis at base of canines 111; least breadth across diastema 82; height at diastema 45; tip to tip of canines 200; lower canines—basal diameter of outer face 19, inner face 20, posterior face 12·5; horizontal length of p_4 15, m_1 19, m_2 26·5, m_3 41.

In conclusion, I may congratulate Lieut. Meinertzhagen on the interest and importance of his capture and ourselves as zoologists on the discovery of so fine a “missing-link” as *Hylochoerus* proves to be. And I would express the hope that before long specimens of this animal may be received in a condition fit for mounting, while further skulls of different ages will elucidate the development of its dentition.

EXPLANATION OF THE PLATES.

PLATE XIV.

Hylochoerus meinertzhageni.

Skull of type; upper, lower, and lateral views.

PLATE XV.

Hylochoerus meinertzhageni.

Figs. 1, 2. Skull of type, anterior and posterior views.

Fig. 3. Upper cheek-teeth, right side, of type.

4. Lower ditto.

5. Upper cheek-teeth, right side, of older specimen.

3. On the Species of Crowned Cranes. By P. CHALMERS MITCHELL, M.A., D.Sc., Secretary to the Society.

[Received November 15, 1904.]

(Text-figures 37-40.)

[The complete account of the new species described in this communication appears here; but since the name and preliminary diagnosis were published in the 'Abstract,' the new species is distinguished by the name being underlined.—EDITOR.]

I have had the good fortune to see no less than fifteen living examples of the Crowned Crane in the course of this year, and the obvious differences between two types heretofore included under the name *Balearica pavonina* led me to examine the literature on the subject and the skins in the National Museum, as well as some shown me by private friends, with the result that I believe I am able to make a slight addition to our knowledge of these beautiful birds.

The two major species of this group were figured by George Edwards, the "Library-Keeper" to the Royal College of Physicians, in his 'Natural History of Birds' (vol. iv. p. 192), published in 1751. They were not definitely named but described as the "Crowned African Cranes": the figure in the foreground, which he supposed to be that of the male of a pair, is a good representation of the Cape Crowned Crane; while the other figure, designated the female by Edwards, is an excellent figure of a West-African Crowned Crane. The latter figure shows the darker coloration of the neck and back, and the division of the bare cheek-area into nearly equal white upper and pink lower half characteristic of the West-African form; while the other figure shows the grey coloration of the upper part of the body and the very large pendent neck-wattle equally characteristic of the Cape form. It will be more convenient to group my subsequent remarks under the names of the species.

Balearica regulorum (Benn.). The Cape Crowned Crane.—I follow Reichenow (Die Vögel Afrikas, vol. i. p. 265) in using this name instead of *B. chrysopelargus* of the B.M. Catalogue. The latter name depends on Lichtenstein's 'Catalogus Rerum Naturalium Rarissimarum,' but the specimens on which Lichtenstein founded his descriptions are not known, and the description of *Ardea chrysopelargus* is far too vague to be applied with certainty to this or any other Crowned Crane. I have seen four living examples (of these, three are at present in the Gardens at Regent's Park) and a number of skins. The feathers of the neck and back are silvery grey. The most striking distinctive characters of the four species, however, are to be found in the heads, of which I give outline figures. The large, bare cheek-patch (text-fig. 37, p. 202) is divided into a small, upper, roughly triangular area which is bright red in colour; the lower part of the patch, which usually

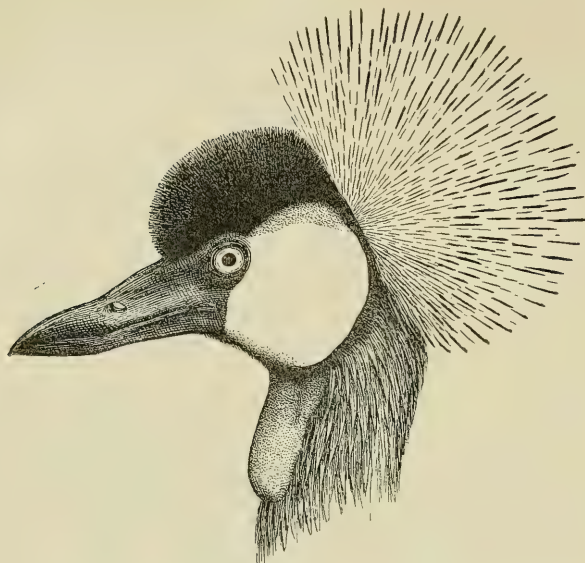
follows the curve of the orbit, is characteristically white in the adult, but may be slightly suffused with pink, as in one of the specimens at the Gardens. Even in that case, however, and in dried specimens from which the colour has faded, the two areas are clearly marked off from one another. The pendent neck-wattle is very large and bright red. The beak is black, and, as in all the others, the part of the head not occupied by the crown is covered with a dense velvety black patch of feathers. The characteristic "crown" in all the species is composed of erect, bristle-like feathers, each of which has a spiral twist. The crown is golden or straw-coloured, but in this species each bristle is tipped with black, and the black often extends a considerable way down the bristles, darkening the crown. On the surface of the skull, in the temporal region, is a pair of very strong bony knobs, described by Mr. Beddard (Proc. Zool. Soc. 1904, vol. ii. p. 131).

This species is widely distributed in South Africa and extends a considerable way northwards in East Africa. Reichenow (*loc. cit.* p. 266) gives its northern range as ceasing with the Pangani River, near Zanzibar. Mr. C. W. Hobley, however, tells me that a Crowned Crane is abundant in Uganda, and has kindly given me the head of a specimen from Kavirondo. This undoubtedly is that of the Cape Crane. Mr. Ogilvie-Grant was kind enough to show me a fine skin from a similar locality which was also that of *B. regulorum*, so that a much more northern range must be associated with this species.

Balearica gibbericeps Reich.—This species is certainly closely allied to *B. regulorum*, and Reichenow in his most recent work does not regard it as more than a variety. I have seen neither living examples nor skins, but reproduce here (text-fig. 38, p. 202), by Dr. Reichenow's kind permission, the figure of the head published in his work 'Deutsch-Ost-Afrika,' Vögel, p. 47. The neck-wattle is large as in the species just described, and the general coloration of the head, neck, and back is similar. The striking difference is the extension forwards and upwards of the bare cheek-patch on either side, so as to invade the black velvety patch in a rounded knob-like process. Various localities are given for this species in the region extending northwards from the Pangani River towards Uganda, but some of these seem ascribed to it on the supposition that the Cape Crowned Crane does not extend northwards of the Pangani. It appears, however, that the two species overlap, and further specimens of *B. gibbericeps* and information about its exact distribution and relation to *B. regulorum* are much to be desired. It is with the hope of obtaining these that I have copied Reichenow's figure and borrowed from his description.

Balearica pavonina (L.). The West-African Crowned Crane.—I have seen seven living specimens and several skins of this species. Five of the living specimens are at present in the Gardens—three brought from Nigeria by Lt.-Col. Jackson, one

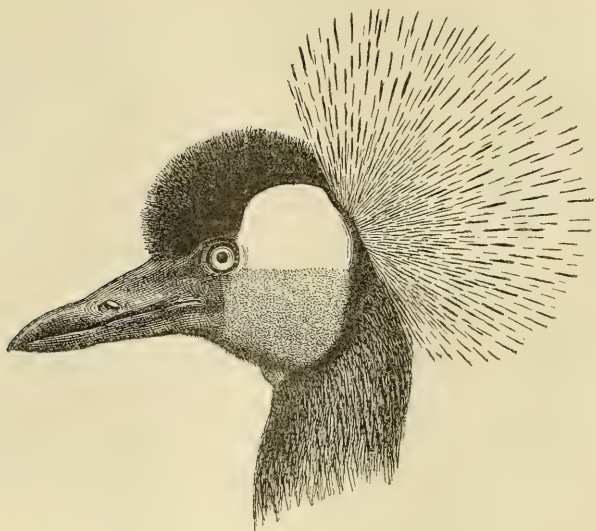
Text-fig. 37.

Head of *Balearica regulorum* (red area of cheek-patch dotted).

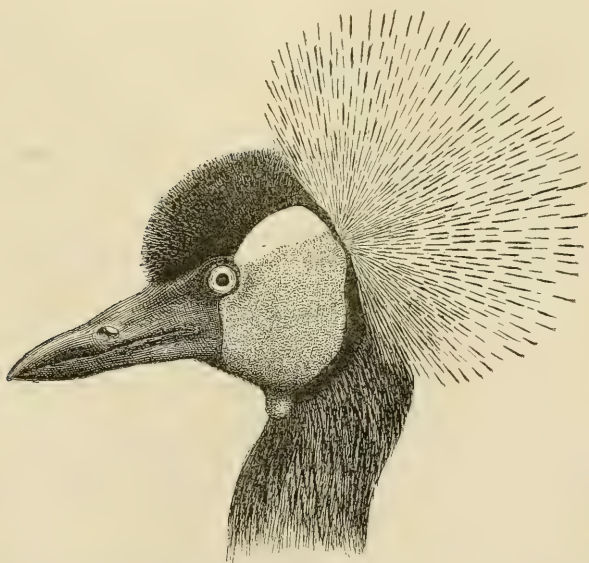
Text-fig. 38.

Head of *Balearica gibbericeps*.

Text-fig. 39.

Head of *Balearica pavonina* (red area of cheek-patch dotted).

Text-fig. 40.

Head of *Balearica ceciliae* (red area of cheek-patch dotted).

obtained from the same locality by Miss Jardine, and another by Dr. Macfarlane. George Edwards's figure, already referred to, is a representation of this bird. It is as large as *B. regulorum*, but much darker in colour, the neck and back, although really a dark grey, looking almost black in comparison with those of the Cape Crane. The crown is almost identical with that of the latter. The beak is similar, but is horn-coloured towards the tip. The skull has similar, although smaller bony knobs, but is much broader and has a larger cranial capacity. The neck-wattles are red, but, although varying in size, are much smaller than in *B. regulorum*, and are visible only when the bird faces the observer. The bare cheek-patch (text-fig. 39, p. 203) is divided by a nearly horizontal line extending backwards from the middle of the orbit into a smaller upper portion which is white, and a larger lower portion which is red, so that the disposition of the colours is inverted compared with that in *B. regulorum* and *B. gibbericeps*. The range of this species is given by both Reichenow and the B.M. Catalogue as extending from Senegal across to the Upper Nile and Abyssinia. It happens, however, that all the specimens I have seen, alive or in museums, of this type (excluding the type about to be described) belong to the Western portion of this range.

BALEARICA CECILÆ Chalmers Mitchell. (The White Nile Crane.)

Balearica ceciliæ Chalmers Mitchell, Abstr. P. Z. S. 1904, No. 10, p. 13, Nov. 22.

The White Nile Crane appears to be the smallest of the Crowned Cranes as yet known. It is rather darker than the West-African form, and the crown, especially in the living specimens, is paler in colour. The beak is shorter and entirely black; the skull and head are relatively smaller, but the velvety helmet is broader, and temporal bony knobs appear to be absent. The cheek-patches (text-fig. 40, p. 203) are rather more rounded than those of *B. pavonina* and the disposition of colour is similar, but the upper white portion is very much smaller, so that at first sight the whole patch appears to be much redder. The neck-wattles are red, and small as in *B. pavonina*.

Early this year Lady William Cecil deposited in the Gardens in Regent's Park four Crowned Cranes which she had obtained from the White Nile, near Khartoum. At first sight they corresponded with *Balearica pavonina*, and they were registered as examples of that species. On comparing them with our other specimens, however, I saw that they differed, and on pointing out their interest to Lady William Cecil, that lady was kind enough to present two to the Society. On further investigation, I thought it necessary to make these birds the type of a new species, which I propose to associate with the name of the donor. In the somewhat poor collection of skins of Crowned Cranes in the National Museum, I found only two belonging to this region of Africa—one

from Fashoda (Hawker Collection), and one from Abou Zeit, White Nile, sent by Captain Stanley Flower; and these two were identical specifically with Lady William Cecil's specimens*.

Type in the Gardens of the Zoological Society of London, presented by Lady William Cecil.

Examples of three species have been living throughout the summer and autumn in the same paddock on the canal-bank in the North Garden. The three examples of *B. regulorum* and one example of *B. paronina* keep together, and the similarity in size is obvious, while the different coloration of the neck and body and of the cheek-patches and the large wattles in the Cape form amply distinguish the species. The two examples of *B. ceciliae* keep together and away from the others. They are smaller, darker in the body, lighter as to the crowns and conspicuously redder as to the cheeks. It would be unwise to attach too much importance as to the natural grouping of birds in a menagerie, but it is striking that *B. paronina* consorts with *B. regulorum*, although the specific distinctness of the two has long been admitted, and not with *B. ceciliae*, with which it has hitherto been confounded.

4. On the Mouse-Hares of the Genus *Ochotona*.

By J. LEWIS BONHOTE, M.A., F.L.S., F.Z.S.

[Received July 18, 1904.]

[The complete account of the new species described in this communication appears here; but since the name and preliminary diagnosis were published in the 'Abstract,' the species is distinguished by the name being underlined.—EDITOR.]

A large and valuable series of *Ochotona* from Kashmir, recently sent home by Col. A. E. Ward, has induced me to take up and study the whole genus, so far as the Palearctic Region is concerned, with the results given below.

Owing to the fact that these animals live in countries difficult to reach and, for the most part, inhospitable, the series of skins is somewhat meagre. Nevertheless I have been enabled to come to certain conclusions which may serve as a basis for the future study of the group.

Exclusive of the American forms, the genus is found in Southern Russia, extending northwards through Persia, Afghanistan, Kashmir, Thibet to N.E. Siberia.

Many of the species are closely allied and some, if not all, have both a summer and a winter pelage. I propose in the first place to divide the genus into three groups, which may be recognised by the shape of the incisive and palatal foramina.

* [Since the reading of this paper, four more Crowned Cranes from the White Nile have been deposited at the Gardens. These are examples of *B. ceciliae*.]

In the first group, which may be called the

Ladacensis Group, the incisive and palatal foramina are separate and distinct, the lower and posterior portions of the præmaxillæ, although very thin, meeting in the middle line.

In the second group, which may be known as the

Rufescens Group, there is no bony division between the incisive and palatal foramina, but the incisive foramen is narrow and slightly constricted at its posterior end, whence it suddenly broadens out into what represents a large palatal foramen.

Lastly, there is the

Curzonie Group, in which the large single foramen is practically triangular in shape, with little or no constriction to mark the division between the incisive and palatal foramina.

The following is a list of all the names belonging to this genus under the special groups to which they belong, as well as the type-locality from which they came. In the body of the paper, however, I have considered some of them as synonyms or subspecies.

I. Ladacensis Group.

Type-Locality.

<i>Ochotona alpina</i>	Altai.
<i>O. hyperborea</i>	N.E. Siberia.
<i>O. normalis</i>	} Mouth of R. Maia, N.E. Siberia.
<i>O. ferruginea</i>	
<i>O. cinereoflava</i>	
<i>O. fusca</i>	
<i>O. littoralis</i>	S. of C. Tschukosky.
<i>O. ladacensis</i>	Ladak.
<i>O. ogotona</i>	Beyond L. Baikal and Desert of
<i>O. erythrotis</i>	Gannsu, N. Thibet. [Gobi.
<i>O. rutila</i>	Vernoe Mts., Turkestan.

II. Rufescens Group.

<i>O. rufescens</i>	Cabul, Afghanistan.
<i>O. koslowi</i>	N. Thibet.
<i>O. pusilla</i>	S.E. Russia and S.W. Siberia.
<i>O. wardi</i>	Kashmir.

III. Curzonie Group.

<i>O. curzonie</i>	Sikkim.
<i>O. melanostoma</i>	Kuku-noor, S. Thibet.
<i>O. daurica</i>	Dauria.
<i>O. macrotis</i>	Doba, Turkestan.
<i>O. aurita</i>	Pangong Lake, Ladak.
<i>O. grisea</i>	Kuenlun R., S. of Sanga Pass.
<i>O. roylei</i>	Choor Mts.
<i>O. nepalensis</i>	Nepal.
<i>O. hodgsoni</i>	Ladak.
<i>O. tibetana</i>	Moupin, N.W. Szechuen.

Key to the Species.

A. Palatal and incisive foramina distinct.

- a*¹. Ears small, 24 mm. or less.
*a*². Colour of upper parts uniform dull rufous.
*a*³. Large. Hind foot 35 mm. *O. alpina*.
*b*³. Smaller. Hind foot 26 mm. *O. hyperborea*.
*b*². Colour of upper parts white or yellowish.
*a*³. Ears rufous *O. ladacensis*.
*b*³. Ears white *O. ogotona*.
*b*¹. Ears large, 28 mm. Colour greyish; head and shoulders rufous.
*a*². Post-auricular patch white *O. rutila*.
*b*². Post-auricular patch red *O. erythrotis*.

B. Palatal and incisive foramina *not* distinct.

- a*¹. Combined foramen narrowing in centre.
*a*². Colour of upper parts uniform.
*a*³. Size large: colour white or yellowish *O. koslowi*.
*b*³. Smaller: colour brown *O. pusilla*.
*b*². Colour of upper parts *not* uniform.
*a*³. Colour brownish, with white collar behind ears *O. rufescens*.
*b*³. Colour greyish, with red head and shoulders in summer *O. wardi*.
*b*¹. Combined foramen *not* narrowing in centre.
*a*². Ears small, 23 mm. or less.
*a*³. Size small. Hind foot 25 mm. *O. hodgsoni*.
*b*³. Larger. Hind foot not less than 28 mm.
*a*¹. Colour light.
*a*³. Mouth black *O. melanostoma*.
*b*³. Mouth white *O. daurica*.
*b*⁴. Colour darker.
*a*⁵. Uniform pale brown *O. curzoniae*.
*b*⁵. Dark brown, rufous on head and shoulders *O. roylei*.
*b*². Ears large, 27 mm. *O. macrotis*.

OCHOTONA ALPINA (Pall.).

Lepus alpinus Pallas, Glires, p. 52, pl. 2 (1778); id. Reise, ii. p. 701, tab. A (1773); Schreber, Säugthiere, iv. p. 911, pl. 238 (1792).

Lagomys alpinus (Pall.) Cuvier, Règ. Anim. p. 219 (1829); Waterh. Mamm. ii. p. 15 (1848); Radde, Reisen Süd. v. Ost-Sibirien, i. p. 232 (1862).

General colour of a uniform reddish brown, sometimes inclined to greyish. Fur long, soft, slate-grey at the base for about three-fourths of its length, the terminal portion being greyish or whitish with darker tip. Ears of moderate size, rounded, and thinly clad with hairs similar in colour to the body-hairs. Under parts uniform yellowish white, being sometimes rather more rufous across the breast.

The skull is stoutly built, but long and narrow. The incisive foramina are small and rounded, rather than narrow and elongate as is the case with other species. The muzzle is broad and stout, and the teeth large and strong.

Dimensions (approx. from skin). Head and body 175 mm.; hind foot 35; ear 20.

Skull. Greatest length 56 mm.; basal length 46; zygomatic breadth 25; length of nasals 18; length of molar series 10; interorbital breadth 6.

Habitat. Originally described from specimens from the Altai.

I have been unable to find any further particulars as to its range.

Our knowledge of this species is so scanty that it is impossible to give any information concerning any changes of pelage it may undergo, but it does not appear to ever become very light. There is a specimen in the British Museum of a uniform deep dark ruddy brown, marked "Siberia, melanistic variety," but further material may prove this to be a normal pelage of the species.

OCHOTONA HYPERBOREA (Pall.).

Lepus hyperboreus Pallas, Zoogr. i. p. 152 (1831).

Lagomys hyperboreus (Pall.) Wagner, Schreber, Säugeth. Suppl. iv. p. 121 (1844); Waterh. Mamm. ii. p. 30 (1848); Schrenck, Amurlande, i. p. 147 (1859); Radde, Reisen Süd. v. Ost-Sibirien, i. p. 232 (1862).

Lagomys hyperboreus, varr. *normalis*, *ferruginea*, *cinereoflava*, *fusca*, Schrenck, Amurlande, i. p. 148 (1859).

Lagomys littoralis Peters, SB. Ges. naturf. Fr. Berlin, p. 95 (1882).

This species closely resembles the foregoing, except in its much smaller size. The five specimens from various parts of Eastern Siberia which are in the British Museum show a uniformity quite unusual among members of this genus. The general colour above is a light brownish rufous (mummy brown, Ridgw.), which is practically uniform throughout the upper parts, becoming rather purer rufous on the flanks owing to the absence of black tips to the hairs. The under parts are of a uniform rufous-white. The ears are small and scantily covered with whitish hairs.

Skull. Except in its size the skull bears a close resemblance to that of *O. alpina*.

Dimensions (approx. from skin). Head and body 160 mm.; hind foot 26; ear 14.

Skull. Zygomatic breadth 20 mm.; length of nasals 11; length of molar series 7; interorbital breadth 5.

Habitat. Described by Pallas as inhabiting N.E. Siberia. Schrenck has recorded it from the mouth of the river Maia on the mainland opposite Sakhalin, and I have examined specimens from Ussuri, Kentei Mountains in N. Mongolia, and Yakutsk.

Schrenck describes, under the names given in the synonymy, several varieties of this species. There can be little doubt as to the specific identity of these varieties, and they probably represent the different pelages assumed by this species, but from the material at my command I am unable to give any further information.

I also provisionally place *O. littoralis*, from a similar locality, under the same name, as a large amount of material will be required before these various forms can be elucidated.

OCHOTONA LADACENSIS (Günth.).

Lagomys ladacensis Günth. Ann. Mag. Nat. Hist. ser. 4, xvi. p. 231 (1875); Blanford, J. A. S. B. xlv. p. 110 (1875); id. Yarkand

Mamm. p. 71, pl. vi. fig. 1, pl. vii. fig. 2, pl. vii a. fig. 1 (1879); id. Faun. Brit. India, Mamm. p. 458 (1891); W. L. Sel. Cat. Calc. Mus. p. 110 (1891); Büchner, Mamm. Przew. i. p. 185 (1890).

Lagomys curzoniae Stoliczka (*nec* Hodgs.), J. A. S. B. xxxiv. 2, p. 108 (1865); Anders. P. Z. S. 1871, p. 562.

General colour light brownish grey, many of the hairs, more especially along the dorsal region, tipped with dark brown. Head rather lighter, with dull rufous patch extending from nose to the crown. Ears moderately large and rounded, clothed externally with rufous hairs, longer on the inner margin. Under parts yellowish white, with a trace of a rufous collar, which is also visible on the shoulders. Feet clothed with white hairs.

The coat just described is that of an individual shot on the 22nd July, and represents a very typical skin; there are, however, other forms of pelage which it would be as well to notice, although I am unable to say exactly in what sequence they may be found.

Specimens in June have, as a rule, very short woolly rufous coats, sometimes shading to pale yellow and interspersed with long black hairs.

In September a moult takes place and the new coat is long and thick and of a warm brownish grey, becoming lighter and paler along the sides. The rufous markings mentioned in the first pelage described are present and visible but not so intense.

There is another specimen from the same place and date as the first mentioned, but the pelage is rather shorter, more woolly, and not so grey.

In a specimen in fresh pelage at the beginning of October the hairs are a deep slate-grey at the base, and shade through vinous to pale white, ending in a buff subterminal ring and a black tip.

I am of opinion that there is only one moult in the year, namely in September, and that during the summer the pelage gradually wears away, giving the animals the different appearances which I have noted above.

Of the *skull* not much need be said as, except in the foramina already alluded to, the specific differences between the skulls in this group are very slight. As, however, the figure given by Büchner (pl. xxiv. fig. 8) is rather misleading, it may be mentioned that the palatal foramen, as shown in fig. 2, much more resembles that of the type of *ladacensis*. In other respects fig. 8 accurately represents *ladacensis*, and it is unfortunate that the specimen figured should have been slightly abnormal in an important feature.

The *dimensions* of an adult male are:—Head and body 180·5 mm.; hind foot 35; ear 24.

Skull. Greatest length 49·5 mm.; basal length 39; zygomatic breadth 25; length of nasals 15; length of molar series 10; interorbital breadth 5.

Habitat. Originally described from Ladak. This species has also been found to the N.E. in Northern Thibet. It is seldom found at a lower elevation than 14,000 feet.

Type. B.M. 75.3.30.2. Collected by Col. J. Biddulph.

OCHOTONA OGOTONA (Pall.).

Lepus ogotona Pallas, Glires, p. 59, pl. 3 (1778); id. Zoogr. i. p. 157 (1811); Schreber, Säugthiere, iv. p. 915, pl. 239 (1792).

Lagomys ogotona (Pall.) Cuvier, Règ. Anim. p. 219 (1829); Waterh. Mamm. ii. p. 17 (1848); Radde, Reisen Süd. v. Ost-Sibirien, i. p. 226 (1862).

Lagomys pallasi Gray, Ann. Mag. Nat. Hist. ser. 3, xx. p. 220 (1867).

Closely allied to *O. ladacensis*, from which it differs in its much greyer and lighter colour; the general colour above being of a pale whitish grey, below white. There is a total absence of the rufous hairs on the ears so conspicuous a feature in the foregoing species.

The skull differs in no marked respect from that of *O. ladacensis*.

Dimensions (approx. from skin). Head and body 165 mm. (6" 7'" as given by Pallas); ear 21; hind foot 35.

Skull. Zygomatic breadth 25 mm.; length of nasals 16; length of molar series 10; interorbital breadth 3·5.

Habitat. Mountains beyond Lake Baikal and Desert of Gobi.

I have examined only one individual of this species, which, except for its colour, very much resembles *O. ladacensis*, of which it may eventually prove to be merely an Eastern race.

OCHOTONA ERYTHROTIS (Büchn.).

Lagomys erythrotis Büchner, Mamm. Przewalski, i. p. 165 (1890); id. loc. cit. pls. xxi. & xxiv. figs. 1-6 (1894).

The following description is taken from Büchner, as I have been unable to procure a specimen of this species. In summer the general colour above is of a dull rusty red; the head is similar in colour to the rest of the body, but the frontal region is somewhat lighter and the lips yellow. The ear is thickly clothed on both sides with ferruginous hairs. The chin is yellowish, the chest reddish, and the remainder of the under parts and feet white. In its winter pelage, the lips and tip of the nose are white, the sides of the face and frontal region are whitish brown. The ears and a small patch immediately behind them are of a rusty red. The remainder of the body above and below is greyish white interspersed with blackish or brownish hairs.

The *skull*, compared with that of *O. ladacensis*, is rather smaller; the muzzle is stouter and shorter, but the skull itself rather narrower. According to Büchner, except for its narrower and more slender build it closely resembles that of *O. rutila*, the next species.

Dimensions (after Büchner). Head and body 245 mm.; ear 28; hind foot 42.

Skull. Greatest length 46·5 mm.; basal length 37; zygomatic breadth 23·7; length of nasals 15·8; length of molar series 8.

Habitat. Gannsu and Burchan Budda Mts., N.E. Thibet.

This species, although clearly belonging to the *ladacensis* group, shows, in its external colouring, affinities towards Col. Ward's new species, to be hereafter described.

OCHOTONA RUTILA (Severtz.).

Lagomys rutilus Severtzoff, Voy. 1873; id. Ann. Mag. Nat. Hist. ser. 4, xviii. p. 168 (1876); Blanf. Mamm. Yark. Miss. p. 79 (1879); Schöff, Zool. Jahrb. (Syst.) ii. p. 65 (1887); Büchn. Mamm. Przew. i. p. 160, pl. xx. (1890); id. loc. cit. p. 191 (1894).

This species apparently differs so slightly from the foregoing that it is doubtful whether they can be considered as more than geographical races.

A male shot on the 21st June in Turkestan has the whole of the back behind the shoulders of a whitish grey. The whole of the head and shoulders, with the exception of the ears, is of a lighter rusty (lighter, according to Büchner, than in *O. erythrotis*). The ears are large, being about the same size as those of *O. macrotis*, and covered on both sides with short grey hairs, while a small patch behind the ears, which in *O. erythrotis* is always red, is in this species always white, and forms the most conspicuous feature distinguishing these two species. The feet are grey; the under parts whitish, with a more rufous collar round the throat.

The skull shows hardly any features to distinguish it from the foregoing.

Dimensions (approx. from skin). Head and body 196 mm.; hind foot 39; ear 28.

Skull. Greatest length 50 mm.; basal length 42; zygomatic breadth 24; length of nasals 16; length of molar series 9.5; interorbital breadth 6.

Habitat. Vernee Mountains, Turkestan.

It seems to me very doubtful whether these last two species can really be regarded as distinct, but our knowledge of them is at present so slight that it seems best meanwhile to consider them so. In the large ears this species resembles *O. macrotis* Günth., while it is perhaps instructive to note that superficially the difference, *e. g.* presence or absence of white postoral patches, between *erythrotis* and *rutila* is very similar to that between *roylei* and *wardi*.

OCHOTONA RUFESCENS (Gray).

Lagomys rufescens Gray, Ann. Mag. Nat. Hist. x. p. 266 (1842); Hutton & Blyth, J. A. S. B. xv. p. 140 (1846); Waterh. Mamm. ii. p. 20 (1848); Horsf. Cat. E.-I. Mus. p. 149 (1851); Blyth, Cat. p. 133 (1863); Blanf. E. Persia, p. 83, pl. 6. fig. 2 (1876); Wood-Mason, P. A. S. B. p. 173 (1880); Scully, J. A. S. B. lvi. p. 76 (1886); Murray, Ann. Mag. Nat. Hist. ser. 5, xiv. p. 100 (1884); Radde, Zool. JB. iv. p. 1053 (1889); W. L. Schl. Cat. Mamm. Calc. Mus. ii. p. 111 (1891); Blanf. Faun. Br. Ind., Mamm. p. 458 (1891).

In its winter pelage (Oct.) this species is of a uniform whitish brown, somewhat paler on the sides and of a pale yellowish buff beneath. Each hair is slate-grey for its basal two-thirds and

then dirty white, with a subterminal buff ring and dark brown tip. The dark tips are absent on the hairs of the feet and under parts, and absent or inconspicuous on a patch behind either ear, which patches tend to meet across the nape. On the frontal region the buff subterminal ring extends down to the grey base and is more rufescent. In summer the pelage is similar, but the colour on the back and head tends to be more rufescent, and that of the flanks and under parts a purer white. The white patches behind the ears are larger, and have coalesced on the nape forming a broad white collar, succeeded posteriorly by a rufescent collar of about half its width, which gradually merges into the general reddish colour of the remainder of the body. This rufescent collar starts from two maroon patches situated on the under side of the neck, and may thence be traced upwards and backwards, becoming paler and more rufous in colour, to meet over the shoulders in the middle line. The maroon patches form a distinctive feature of this species, but they are not always to be seen in the winter pelage.

The *skull* may best be described by comparing it with that of *O. ladacensis*, from which it differs in being broader across the muzzle. The bullæ are more rounded and swollen, thereby narrowing the basioccipital. The main difference, however, lies in the incisive and palatal foramina, which are not, as in *O. ladacensis*, separated, but form one large foramen slightly constricted about one-third of the way from its anterior end. The portion anterior to this constriction is of uniform width and narrow, the posterior portion gradually widening out throughout its length. This distinction forms the difference between the two groups.

Dimensions (approx. from skin). Head and body 175 mm.; hind foot 32; ear 22.

Skull. Greatest length 52 mm.; basal length 42; zygomatic breadth 24; length of nasals 16; length of molar series 10; interorbital breadth 3.

Habitat. The type came from Barber's Tomb, Rocky Hills, near Cabul; but its range extends throughout Afghanistan, extending into Persia and Transcaspia.

The white collar and maroon patches on the throat form characters by which this species may readily be recognised, but even apart from these it does not bear a very close resemblance to any of the species which have hitherto been described.

OCHOTONA KOSLOWI (Büchn.).

Lagomys koslowi Büchner, Mamm. Przewalski, i. p. 187 (1894).

Size rather large. General colour of the upper parts, which is uniform throughout, pale whitish buff tinged with vinaceous. Under parts and feet, which are thickly furred, white. Each hair is grey for about half its length at the base, the terminal half being vinaceous buff fading to whitish or ending in a dark brown tip, which last is never sufficiently conspicuous to modify

the general colour. Intermixed with the fur proper are some long black bristles. I fancy that in its changes of pelage this species closely follows *O. ladacensis*, for at the end of summer it is of a bright golden buff due to the wearing off of the terminal portions of the winter pelage described above. The long black bristles, however, do not wear down and thus become more conspicuous.

The *skull*, which is well figured by Büchner, is rather short in the muzzle, giving it a broad and thick-set appearance. The muzzle is both short and narrow, and possibly in correlation with this we find the anterior terminal portion of the nasals tending to turn upwards to a marked extent and having a broad vertical portion. The foramina are as in *O. rufescens*.

Dimensions of skin (after Büchner). Head and body 240 mm.; hind foot 42; ear 19·5.

Skull. Greatest length 44 mm.; basal length 33; zygomatic breadth 27·2; length of nasals 14·3; length of molar series 10.

Habitat. Northern Thibet.

This species may easily, apart from skull-characters, be distinguished from *O. ladacensis*, with which alone it could be confused, by the ears being yellow and not rufous, the tips white *not* black, and the under parts snowy white and *not* yellowish.

OCHOTONA PUSILLA (Pall.).

Lepus pusillus Pallas, Glires, p. 37, pl. i. (1778); Schreb. Säugth. iv. p. 906, pl. 237 (1792).

Lagomys pusillus (Pall.), Desm. Mamm. p. 353 (1820); Cuv. Règne Anim. p. 219 (1829); Waterh. Mamm. ii. p. 19, pl. i. fig. 2 (1848).

This is the smallest species of the genus as yet known. The general colour above, which is uniform, is dark brown, grizzled with white where the whitish median portion of each hair shows through. Under parts white; ears and feet grizzled, the former having a conspicuous ring of white hairs growing from their inner margin.

The *skull*.—From the material at hand I am unable to say much about the skull, which is small but well proportioned, the muzzle being rather stout and short. The foramen is very typical of the group in which I have placed it.

Dimensions (approx. from stuffed specimen). Head and body 145 mm.; hind foot 27; ear 14.

Skull. Zygomatic breadth 20 mm.; length of nasals 12; length of molar series 7; length of palate from henselion 8·5.

Habitat. S.E. Russia and thence eastward to Siberia.

Material is so scarce that it is impossible to say much concerning this species, which may be recognised by its small size and the white rims to the ears, in which characters it approaches *O. hodgsoni* from Kashmir.

OCHOTONA WARDI Bonhote.

Ochotona wardi Bonhote, Abstr. P.Z.S. 1904, No. 10, p. 13, Nov. 22.

In the summer pelage, worn from June to September, the whole of the head, shoulders, and fore part of the body (excepting a small patch behind the ears, which is white) is bright chestnut (cinnamon-rufous, Ridgw.), becoming more vinaceous on the throat. The remainder of the upper parts is dark greyish rufous, each hair being black at its base with a light subterminal annulation, the tips being either dark or rufous. This latter colour encroaches greatly on the light portion often to its total exclusion, especially on the sides of the body. The under parts are white lightly washed with pale buff. The feet are of the same colour. Ears moderate in size, very scantily clothed with hair.

In the winter pelage this animal is of a uniform dark iron-grey all over, with the exception of the light patches behind the ear, which are white as in summer. Under parts dull white. Slight traces of rufous are generally to be found at the base of the shoulders, on the crown of the head, and along the flanks. The young resemble the adults in winter, but are slightly browner in general colour and have the rufous on the head and shoulders more marked.

The *skull* is very similar to that of the type of *O. roylei*, as figured in the original description, and does not show any great features of note. The combined foramen, while having the narrow anterior third and the slight constriction typical of the *rufescens* group, shows a tendency for the constriction to become less marked, but it can nevertheless be clearly made out in every example.

Dimensions of type in flesh. Head and body 187 mm.; hind foot 25; ear 22.5.

Skull. Greatest length 44 mm.; basal length 37; palatal length 17; length of foramen 12; zygomatic breadth 21; interorbital breadth 5; breadth of brain-case 17; length of molar series 9.

Habitat. Talien, Kashmir, 11,000 feet.

Type (in Coll. Brit. Mus.). A.E.W. No. 56. Ad. ♂. Collected on the 8th August, 1903.

In external appearance this species most nearly resembles *O. roylei*; the latter, however, is much darker and lacks the conspicuous white patches behind the ears.

OCHOTONA CURZONIE Hodgs.

Lagomys curzonie Hodgs. (*nec* Stoliczka) J. A. S. B. xxvi. p. 207 (1858); Günth. Ann. Mag. Nat. Hist. ser. 4, xvi. p. 230 (1875); Blanford, Fauna Br. Ind., Mamm. p. 457 (1891).

This is the first species of the group which I have called after it and which is very closely related to the *rufescens* group. The difference between the palatal foramina of the two is well shown by a comparison of the figures of *O. kosłowi* (Büchn. Mamm.

Przewalski, pl. xxiv. fig. 14) and of *O. daurica* (ibid. pl. xxv. fig. 2); in which it may be noticed that the sides of the foramen in *O. daurica* diverge at once from their anterior point instead of continuing parallel for the first third of their length, and then tending to approach again before finally diverging, as in the *rufescens* group.

O. curzonie is a pale buff-coloured animal above and rather lighter below. Along the median area of the back the hairs are tipped with black and have a subterminal ring of rufous brown, the extent of the rufous varying in individual specimens. Behind the ears is a clear patch of a rather deeper buff than the rest of the body. The ears are of moderate size, clothed on both sides with fairly long whitish hairs. Feet pale buff.

The *skull* of this species is small and narrow. Apart from the palatal foramen, of which mention has already been made, the chief point of note is the postorbital process of the zygoma, which is very long and narrow; the posterior nares are similarly modified.

Dimensions (approx. from skin). Head and body 170 mm.; hind foot 28; ear 19.

Skull. Palatal length 15 mm.; zygomatic breadth 20; length of nasals 12; length of molar series 8; interorbital breadth 4.

Habitat. The type-locality of this species is the Chumbi Valley in the north of Sikkim, whence it apparently extends westward as far as Kashmir.

The series of this species at my disposal is so small, that I am unable to give any particulars of its seasonal changes should any occur, but from the specimens before me it appears to be a very uniform species.

OCHOTONA MELANOSTOMA (Büchn.).

Lagomys melanostomus Büchn. Mamm. Przewalski, i. p. 177, pl. xxii. (1890).

Except in its slightly larger size I can find, after careful comparison of a co-type of *melanostoma* with the types of *curzonie*, no other distinguishing characteristics between these two species, and possibly a larger series of the latter would prove them to be identical. Büchner, in his original description, had apparently overlooked *O. curzonie*, as he only distinguishes it from *O. daurica*, from which it differs in its yellowish under parts and black muzzle. The general colour of the winter pelage above is sandy brown grizzled with darker brown or blackish. Each hair at its base is grey, shading to light brown and ending in a dark tip. Interspersed over the upper parts are long uniformly black hairs. The under parts are dirty yellowish white.

In summer the hairs wear down so that the light-brown subterminal rings become more conspicuous, the black tips being nearly or quite worn away; the long and uniformly black hairs, however, remain, so that the grizzled appearance is not altogether lost, but the animal becomes brighter and browner and the under parts tend to become of a purer white.

The *skull*, except in size, does not differ from that of *O. curzonie*.

Dimensions (after Büchner). Head and body 235 mm.; hind foot 34; ear 21.

Skull. Greatest length 41 mm.; basal length 36; palatal length 16; zygomatic breadth 21·5; length of nasals 13; length of molar series 9; interorbital breadth 4.

Habitat. Kuku-noor and Gannsu, N. Thibet.

OCHOTONA DAURICA (Pall.).

Lepus dauricus Pall. Reise, iii. 1776, p. 692.

Lagomys dauricus (Pall.), Büchn. Mamm. Przewalski, i. p. 172, pl. xxii. fig. 1 & pl. xxv. figs. 1-5 (1890).

The general colour of this species is a very pale buff, lighter on the flanks and rather yellower along the centre of the back and over the forehead. Each hair is dark slate-grey at the base, succeeded by a whitish portion, increasing in colour towards the tip, which is sometimes dark brown. Ears well covered with whitish hairs; feet white. Under parts pure white, having occasionally a yellowish collar round the neck.

The skulls at my disposal are too fragmentary for a detailed description. Büchner, however, gives a good figure, from which it appears to differ but little from the nearly allied species. Its most marked features are the bullæ, which are large, prominent, and rounded.

Dimensions (after Büchner). Head and body 220 mm.; hind foot 14·5; ear 19.

Skull. Palatal length 18 mm.; length of nasals 14·5; length of molar series 8·5.

Habitat. Originally described from Dauria.

Much confusion seems to exist over this species, which closely resembles at least three others, viz. *O. curzonie*, *melanostoma*, and *ogotona*.

The black muzzle of *O. melanostoma* serves at once as a distinguishing character, while from *O. curzonie* the paler colour of the present species as well as the longer and softer coat form characters by which it may always be distinguished.

From *O. ogotona*, to which it bears a greater external resemblance, and with which it has been confounded by Büchner, it may be distinguished by its much smaller size, while the skull-characters are very distinct.

OCHOTONA MACROTIS (Günth.).

Lagomys macrotis Günth. Ann. Mag. Nat. Hist. ser. 4, xvi. p. 231 (Sept. 1875); Blanford, Yark. Mamm. p. 75 (1879); Scully, Ann. Mag. Nat. Hist. ser. 5, vol. viii. p. 100 (1891); id. P. Z. S. 1881, p. 207; W. L. Sci. Cat. Mamm. Ind. Mus. p. 110 (1891); Blanford, Faun. Br. India, Mamm. p. 457 (1891).

Lagomys auritus Blanford, J. A. S. B. vol. xlv. p. 111 (Oct

1875); id. J. A. S. B. xlv. p. 326 (1877); id. Yark. Mamm. p. 74, pl. vi. fig. 2, pl. vii a. fig. 2 (1879).

Lagomys griseus Blanford, J. A. S. B. vol. xlv. p. 111 (Oct. 1875); id. Yark. Mamm. p. 77, pl. vii. fig. 1, pl. vii a. fig. 3 (1879).

Superficially this species is not unlike a pale form of *O. rutila*, but a glance at the skull shows it to belong to the *curzonie* group, and its large ears will prevent confusion with any other members of that group.

This species is of moderate size, and the general colour above is pale brownish grey, each hair being dark-coloured at its base, white in the centre, and pale buff subterminally with a black tip. Apparently it moults only once a year, in August, but in summer the hair is much abraded and the animal is then much whiter. The under parts and feet are white. Along the sides of the face, across the shoulders, and from the nose over the occiput, the general greyish colour is tinged with rufous, this rufous being more marked in summer; the eye is surrounded by an ill-defined greyish ring. The inner sides of the ears and a patch behind are white, the outer sides having dark brown hairs with white tips.

The skull belongs typically to the *curzonie* group, the sides of the combined palatal and incisive foramina sloping outwards in a regular slant from their anterior point. Another peculiarity about the skull is the presence of two small oval foramina above and in front of the orbit at the anterior end of the frontal bones. These foramina, which measure about 3 mm. by 1.5 mm., are constant and uniform in all specimens of this species that I have examined, though they may also be found sporadically throughout the genus. In other respects there is nothing of note to be observed in the skulls.

Dimensions (from skin). Head and body 200 mm.; ear 27; hind foot 32.

Skull. Palatal length 17 mm.; zygomatic breadth 23; length of nasals 14; length of molar series 9.

Habitat. Doba, Kuenlun Mts.; Pamirs; Ladak.

The large ears, correlated with skull-characters, enable this species to be easily recognised.

There are two species, *O. aurita* and *O. grisea*, described by Blanford, which may probably be assigned to this species. I have not had the opportunity of comparing any specimens, but from the description and figures there can be no doubt that, if not identical, they are very closely allied to *O. macrotis*.

OCHOTONA ROYLEI (Ogilby).

Lagomys roylei Ogilby, Royle's Him. Bot. p. lxix, pl. iv. (1839) id. Geoffr. Voy. Jacquemont, Mamm. p. 62 (1841); Waterh. Mamm. ii. p. 26 (1848); Adams, P. Z. S. 1858, p. 520; Blyth Cat. p. 133 (1863); Jerd. Mamm. p. 226 (1867); Blanf. J. A. S. B. xli. pt. 2, p. 35 (1872); Lydekker, J. A. S. B. xlv. p. 286 (1877); Scully, Ann. Mag. Nat. Hist. ser. 5, vol. viii. p. 100 (1881)

Büchn. Mamm. Przew. i. p. 156, pl. xxiii. figs. 1, 2 (1890); W. L. Schlater, Cat. Mamm. Calc. Mus. p. 112 (1891); Blanf. Faun. Br. Ind., Mamm. p. 456 (1891).

Lagomys nepalensis Hodgson, J. A. S. B. x. p. 854 (1841), fig. p. 816; id. J. A. S. B. xi. p. 289 (1842); Waterh. Mamm. ii. p. 24 (1848); Gray, Cat. Hodgs. Coll. p. 21 (1846); Horsfield, Cat. E.-I. Mus. p. 148 (1851); Günth. Ann. Mag. Nat. Hist. (4) vol. xvi. p. 230 (1875).

General colour in winter dark brown grizzled with buff, each hair being dark brown with a buff subterminal annulation. The head shows traces of rufous. Under parts white. Feet rufous-buff. The summer pelage is similar, but the head, shoulders, and flanks are bright rufous (hazel, Ridgw.), the head being slightly grizzled with black. Under parts sometimes showing a pale median rufous streak.

The *skull* shows no very distinctive features. It is long and narrow, and the nasal bones, especially at their anterior end, broad.

Dimensions (from skin). Head and body 175 mm.; hind foot 32; ear 23.

Skull. Palatal length 15.5 mm.; zygomatic breadth 20; length of nasals 12; length of molar series 1; interorbital breadth 6; breadth of nasals 7.

Habitat. Kashmir; Nepal.

The external differences between this species and *O. wardi* have been pointed out in the description of the latter species; and although somewhat alike, the skull-characters enable them to be easily separated. The series of this species being very small, I have been unable to separate *roylei* from *nepalensis*. I fancy, however, that a large series would prove them to be subspecifically distinct. The type of *roylei* came from the Choor Mts., a little to the west of Kumaon, and the type of *nepalensis* from E. Nepal, north of Katmandu.

OCHOTONA HODGSONI (Blyth).

Lagomys hodgsoni Blyth, J. A. S. B. x. p. 817, pl. p. 844 (1841); Waterh. Mamm. ii. p. 23 (1848); Gray, Ann. Mag. Nat. Hist. ser. 3, xx. p. 220 (1867).

Lagomys tibetanus Milne-Edw. Nouv. Arch. Mus. vii. p. 93 (1871); id. Rech. Mamm. p. 314 (1872).

General colour above dull dark reddish brown, shading to pale buffy brown on the flanks. The under parts are of a dirty white, having a reddish median band. The upper sides of the feet are lighter than the rest of the body and slightly tinged with rufous.

The skulls are so fragmentary that I am unable to give a detailed description. The incisive foramina are much more triangular in shape than in *roylei*, and their margins tend to slope out gradually from the apex.

Dimensions (as given by Blyth). Head and body 6 ins. (150 mm.); hind foot 1.25 in. (32 mm.).

Skull. Palatal length 12 mm.; zygomatic breadth 15; length of molar series 6.5; length of nasals 10; interorbital breadth 4.

Habitat. Kashmir; Tibet; Szechuen.

This species is allied to the preceding, the dull pelage of which it greatly resembles; its much smaller size will, however, enable it to be easily recognised.

I have seen no specimens from Kashmir, the type-locality of this species, but there is a series of specimens in the Museum from E. Sikkim, which agree so closely with Blyth's description, that I have no hesitation in referring them to this species. I have also examined specimens from Szechuen, which are indistinguishable from those of E. Sikkim, as well as a single individual from Gamsu in N. Thibet. M. Milne-Edwards' species from Moupin is also, in my opinion, identical with *O. hodgsoni*, of which it therefore becomes a synonym.

Since the foregoing has been in the possession of the Society, Mr. Marcus W. Lyon, jun., has published* an exhaustive paper on "The Classification of the Hares and their Allies," founded almost entirely, as would naturally be the case, on their osteological characters. He divides the genus *Ochotona* (l. c. p. 438) into three subgenera founded on cranial characters, and it is gratifying to find that his subgenera correspond with the three groups into which I have found it necessary to subdivide the genus, as set out in this paper. For the names of his subgenera Mr. Lyon makes use of two previously existing, viz. *Ochotona* and *Pika*, and coins a new one, *Conothoa*. The subgenera *Ochotona*, *Conothoa*, and *Pika* represent respectively the *rufescens*, *curzoniae*, and *ladacensis* groups of this paper.

With regard to the actual classification of some of the species, there are several apparent discrepancies between Mr. Lyon's results and my own. In considering these, however, it must be borne in mind that Mr. Lyons was treating the subject from a larger point of view and also almost entirely from the osteological side; whereas in my work geographical distribution and external characters were more especially studied, and I had the additional advantage of superior series of skins, owing to many of the actual types being in the Museum, as well as a nearly complete set from Büchner of the various species he had described.

The first discrepancy is the grouping together of *O. ladacensis* and *O. koslovi*. The figure given by Büchner of the skull of the former does not agree with the type skull, as I have already pointed out (*antea* p. 209), which undoubtedly belongs to the same group as *O. alpina*, and there can be but little doubt that Büchner's figure misled Mr. Lyon.

The next discrepancy is with regard to *O. erythrotis*, which Mr. Lyon, on the strength of Büchner's figure, places in the *curzoniae* group. I have not been able to examine specimens of *O. erythrotis*, but there are in the Museum a series of *O. rutila*

* Smithsonian Miscell. Coll. vol. xlv. p. 321 (1904).

which, according to Büchner, very closely resemble *O. erythrotis*. Büchner's actual words are :—" Die Incisivöffnung ist durch einen paarigen Vorsprung des Zwischenkiefers in zwei Abschnitte, eine vordere und eine hintere Incisivöffnung getrennt; in Form und Grösse gleichen diese Oeffnungen vollständig denjenigen bei *L. rutilus* "; and on the strength of this I have no hesitation in placing *O. erythrotis* in the *ladacensis* (subgen. *Pika*) group, a finding with which Mr. Lyon, had he seen specimens of *O. rutila*, would, I feel, sure agree.

The only other discrepancies relate to *O. curzoniae*, *O. daurica*, *O. melanostoma*, and *O. pusilla*, but as Mr. Lyon has never seen specimens or figures of any of these, his conclusions with regard to them must of necessity be of a rather speculative character.

To sum up shortly, we may fairly consider Mr. Lyon's conclusions as regards the main divisions of the genus to be clearly borne out by the foregoing pages, and, so far as the Palæarctic species are concerned, this paper may claim to have clearly shown to which subgenus any particular species should be assigned.

5. On some Edible and other New Species of Earthworms from the North Island of New Zealand. By W. B. BENHAM, D.Sc., M.A., F.Z.S., Professor of Biology in the University of Otago, New Zealand.

[Received May 31, 1904.]

(Text-figures 41-82.)

The Earthworms that have hitherto been described from New Zealand by Mr. Beddard and by myself have been collected, with one exception, from the South Island, and indeed from the southern half of that island. The majority of these belong to the genera *Maoridrilus*, *Notiodrilus*, and *Plagiochaeta*, belonging to the subfamily Acanthodrilinae, and to the genus *Octochaetus*, of Michaelsen's subfamily Octochaetinae; and the general *facies* of our South Island fauna is very characteristic and quite distinct from the Australian Earthworms. But I have recently been able to examine specimens of a number of species from various parts of the North Island, with the astonishing result that they present a striking contrast to those of the South Island, and as striking a resemblance to the Australian Cryptodrilids. Even in the South Island we have in two species of *Diporochaeta*, and the lacustrine species of *Plutellus*, representatives of the Australian fauna; but whereas the species just referred to are by no means common, and might probably be regarded as comparatively recent arrivals, possibly even accidentally introduced from the adjoining continent, such an explanation appears to be quite inadmissible for the northern species; for the new genus *Tokea*, which I find it necessary to make, is represented by seven species in quite distant parts of the North Island; and the Acanthodriline genera are just as scarce

in the North Island as the *Cryptodrilinae* forms are in the South ; moreover, most of these worms are found in inland places, or in spots more or less remote from European cultivation ; and, indeed, some of the species were formerly used as food by the Maoris, who recognise several different species of Earthworms and give distinctive names thereto.

Before attempting to explain this Australian faunal resemblance of the North Island, we must wait till we can obtain more material, both from the southern portion of that island and the northern districts of the South Island.

Another interesting group of Worms is also represented in the collection, viz., two new species of *Rhododrilus*—a genus peculiar to New Zealand, but allied to *Microscolex*, which is an American form.

Finally, I find it necessary to create a new genus, *Dinodriloides*, for a worm which bears the same relation to *Dinodrilus* that *Neodrilus* bears to *Maoridrilus*, in that the hinder pair of prostates has disappeared ; though this is not the only point of difference from Beddard's genus.

For the majority of the species described below I am indebted to Mr. Elsdon Best, of Ruatahuna, who, at my request, took the trouble to collect, preserve, and despatch to me, in February 1904, several kinds of worm that were formerly used as food by the Maories, of which he has written an account in the 'Transactions of the New Zealand Institute' for 1901, on p. 64, in his article on "The Food-products of Tuhoe-land." Tuhoe-land or the Urewera Country lies on the eastern part of the North Island, south of the Bay of Plenty, and not far from Rotorua, so famous for its baths. The country is much rougher and less affected by civilisation than elsewhere, and is still peopled by Maories in a less Europeanised condition than in other parts.

In this article Mr. Best enumerates and gives a brief description of eight different kinds of earthworm as being eaten by the natives : these are "Kuharu, Noru, Wharu, Tarao, Pokotea, Tai, Kurekure, and Whiti." The "two last are famed for their sweetness and flavour," and "were reserved as food for the chiefs. The sweet flavour is said to remain in the mouth for two days," though Mr. Best states that he "cannot speak from experience" as to this fact.

In preparing these worms for food, "those which contain earth are stripped with the fingers before being prepared for eating, this forces the earth out of them." I suppose this means "stripping" in the way fish are "stripped" of their milt and ova, in hatcheries.

"To cook these worms some water is placed in a bowl and rendered warm (not hot) by means of hot stones. The worms are then cast into the water and allowed to remain there for some hours. Before long the worms will have become dissolved or partially so, but were the water too hot they would not melt. Some cooked greens are added to the mess, and a prized dish is

ready; the gods who live for ever would smile at the sight of it."

"Worms were preserved in gourds for some time. The best kinds were favourite *o matengo* of former days; the last food taken by a dying person is so termed."

Of the earthworms referred to in this extract, Mr. Best sent me specimens of "Tarao," "Pokotea," and "Kurekure," as well as another earthworm, called by the natives "Tokerangi," but not included in his list of foods.

"Tarao" and "Tokerangi" belong to the genus *Rhododrilus*; "Kurekure" and "Pokotea" to the new genus *Tokea*. But "Kurekure" includes two species, so that we have four (or five if "Tokerangi" is eaten) species of edible earthworms, belonging to two distinct genera. I believe this is the first time that the use of Oligochæta as an article of diet has been recorded; for no mention is made of earthworms in the series of Animals used as Food enumerated by Professor Lankester in his introduction to the recently published volume of "Reports on Economic Zoology," issued from the British Museum.

The following is a list of the twelve new species of Earthworms described in the present paper: I desire to express my thanks to my various friends and correspondents who have so kindly collected these, and other, worms in out of the way districts.

Fam. MEGASCOLECIDÆ.

Subfam. ACANTHODRILINÆ.

- Maoridrilus maviensis*.
- Octochaetus michaelsoni*.
- Dinodriloides beddardi*.
- Rhododrilus edulis*.
- Rhododrilus besti*.

Subfam. MEGASCOLECINÆ.

- Tokea*, gen. n.
- T. esculenta*.
- T. sapida*.
- T. ureveræ*.
- T. huttoni*.
- T. suteri*.
- T. kirki*.
- T. maorica*.

MAORIDRILUS MAUIENSIS, sp. n. (Text-figs. 41-44.)

A single incomplete specimen, collected in 1899 by Mr. Suter and now preserved in alcohol. It is soft and ill-preserved.

Locality. Auckland.

Colour. Pale yellowish, in marked contrast to the usual dark tint of members of the genus; possibly the pigment has been dissolved.

Dimensions. 80×4 mm., for 117 segments.

Prostomium tauglobic.

Chaeta. 8, closely coupled; $aa < bc = dd$.

Clitellum undeveloped.

Genital pores.—The porophores* in 17 and 19 are in line of chaetae *ab*, which are absent. The spermathecal groove passes straight backwards between *a* and *b*, which are present on 18 in the manner characteristic of the genus; spermathecal pores normal in number and position, in line *ab*.

Internal Anatomy.

The septa behind segments 8 to 14 slightly thickened.

Text-fig. 42.



Text-fig. 41.

Text-fig. 41. *Maoridrillus maviensis*.—A spermatheca ($\times 12$: camera outline): no structural difference could be detected between the two lobes of the sac, to enable a distinction of diverticulum and ampulla to be made.

Text-fig. 42. *Maoridrillus maviensis*.—A penial chaeta ($\times 30$. Laty oc. 1, obj. 2, camera).

* I have suggested, in an article on *M. uliginosus* (Tr. N.Z. I. 1900, p. 125), this name for papillae carrying the male or prostate pores.

Dorsal vessel double; last heart in 13th segment.

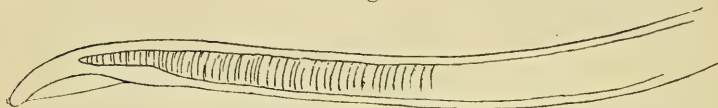
Gizzard large; œsophagus with 3 pairs of glands, quite distinct and typically developed, situated in segments 13, 14, 15, the last more dorsally placed and smaller than the preceding.

Sperm-sacs of fair size, in segments 11, 12; botryoidal.

Prostates* normal. Penial chaetæ delicate, much curved in an exaggerated S-shape, with the tip spoon-shaped, though pointed and curved in side view.

The *spermatheca* are of peculiar form (text-fig. 41, p. 223). Each consists of a bilobed sac; the two lobes are of about the same size and irregularly ovoid, and joined by a short, narrow isthmus, whence the muscular duct originates. One might imagine that one lobe is a "diverticulum" in the usual sense, but examination of stained specimens shows no structural difference between them;

Text-fig. 43.



Maoridrilus muiensis.—Tip of penial chaeta, side view ($\times 350$. Oc. 1, obj. 7, camera).

Text-fig. 44.



Maoridrilus muiensis.—Tip of penial chaeta; view of plane at right angles to the above (? perhaps the extreme tip is injured).

the epithelium is folded, irregular, and apparently glandular, as a quantity of stained material is present in the lumen; I could see no spermatozoa. As a rule, there is a marked difference in structure between sac and diverticulum. Unfortunately the specimen is not sufficiently well preserved to enable me to decide this question.

At any rate the form of the spermatheca and the arrangement of the œsophageal glands mark the species from any of those hitherto described.

This is the first species of *Maoridrilus* described from the North Island, and is the only specimen amongst the material I have received from various correspondents collected in several widely scattered districts.

* No doubt Beddard's term "spermiducal gland" is in some respects better, but it is a clumsy term, and when "duct" is added it is by no means euphonious.

OCTOCHÆTUS MICHAELSENI, sp. n. (Text-fig. 45.)

A single individual of this worm was collected by Capt. F. W. Hutton at Wellington. It was broken into four or five pieces when I received it; in general appearance it agrees with other species of the genus.

Dimensions. About 210×8 mm.; the number of segments was not counted, as the worm was too greatly contracted and broken to make the attempt profitable.

The *clitellum*, though not fully developed, appears to cover segments 15 to 19.

The porophores are in line of *b*, as also are the spermathecal pores, and their position on the body is lateral rather than ventral, though of course on the under side.

The *chaetae* have the usual spaced arrangement, and, in spite of examination of the skin, I was unable to detect them in front of the tenth segment.

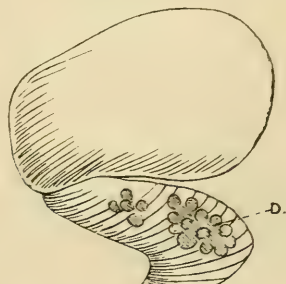
The arrangement is as follows: *d* is a little above the lateral line, so that *d-d* is about $\frac{1}{3}$ of the circumference, $aa = cd = 1\frac{1}{2} ab$; $ab = bc$. The gap *aa* is wider in the clitellar and preclitellar segments than posteriorly.

Internal Anatomy.

There are seven very stout septa, the last being behind the 12th segment.

The dorsal vessel is double as far forward as segment 8, and the last heart is in the 13th segment.

Text-fig. 45.



Octochætus michaelсени.—Spermatheca ($\times 12$): the diverticulum is represented by several small saccules (D) embedded in the thickness of the muscular duct.

The long gizzard is in the 6th segment, with the thin septum five-sixths attached near its anterior margin.

The œsophagus bears a single pair of glands in the 15th segment and is well marked and hemispherical, though a good deal compressed antero-posteriorly owing to the contractions of the body.

The intestine commences in the 16th segment.

With regard to the *reproductive system*, the testes and ovaries are on the posterior wall of their segments, as in *O. thomasi* and other species. The penial chætæ are small and do not appear internally, but on each of the prostate pores, when examined under a lens, the broken bases of two dark chætæ are visible.

The spermathecae are unsymmetrically developed; on the right side the normal two pairs are present in segments 8 and 9, but on the left side the anterior sac is absent. Each spermatheca is a simple ovoid sac (text-fig. 45, p. 225), with a short, thick duct which forms an acute angle with the sac (probably owing to the contraction of the body). There is apparently no diverticulum, but in the stained and clarified organ there are seen to be a number of small saccules, irregularly arranged and embedded in the wall of the duct; they do not form any projection, but are situated in the widest part of the duct, where it is bending to reach the body-wall; and though I have not yet sectionised the organ, it appears as if their presence here caused the duct to be of greater diameter at this spot.

Remarks.—The form of the spermatheca and the arrangement of the œsophageal glands suffice to distinguish this species from any hitherto described.

DINODRILOIDES, gen. nov.

Chætæ 12 per segment. Clitellum girdle-like, on segments 14–16 (= 3 segments). Prostate pores, one pair, on the 17th, and male pore on 18th segment. A single spermatheca, opening at 8/9. Meganephric: pores in line not alternating. Gizzard in segment 6. 2 pairs of testes, segments 10, 11. 2 pairs sperm-sacs, in segments 11, 12. Prostates: a single pair much coiled, cylindrical.

DINODRILOIDES BEDDARDI, sp. n. (Text-figs. 46, 47.)

A single specimen of this interesting worm was collected by Mr. H. Suter at Auckland.

The *colour* (in the specimen preserved in alcohol) is a very distinctive bluish grey, equally dark in tint along the entire length, and the pigment extends down the sides to the ventral surface, which, however, is paler and becomes yellowish in the hinder region. The clitellum is yellow-brown.

The worm consists of 95 segments, and measures 78 mm. × 4 mm.

The *chætæ* are arranged as in *Dinodrilus**—that is to say, there are 12 in each segment; in 3 couples on each side, the individuals of which are widely separated, so that the 6 are practically equidistant, while the dorsal and ventral gaps are only slightly greater than the other gaps. The middle couple (*c-d*) are lateral in position.

* Prof. Spencer has recently described an Australian Cryptodriline genus, *Trichæta*, with six couples of chætæ (*vide* Proc. Roy. Soc. 1900, p. 30).

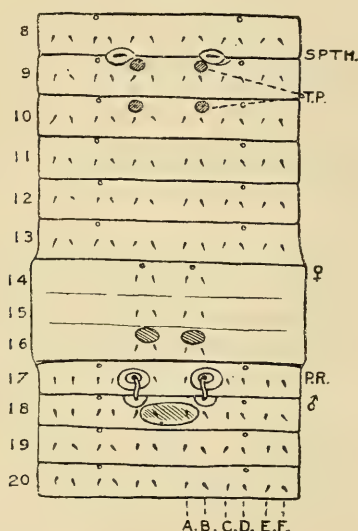
Each chaeta is carried on a slight papilla (in the preserved specimen), which is very pale and, indeed, nearly white.

The *prostomium* is only slightly, if at all, embedded, but as the buccal region is everted, producing wrinkles on the peristomium, it is impossible to detect the actual limits of the prostomium.

The *clitellum* is fully developed and very well-defined, both in front and behind; it completely surrounds segments 14, 15, 16.

Genital pores, &c. (text-fig. 46).—The most remarkable thing about the worm, in which it contrasts with *Dinodrilus*, is the presence of only one pair of "porophores" bearing the pores of the spermiducal glands, which are situated on the 17th segment

Text-fig. 46.



Dinodriloides beddardi.—View of part of the fore-body, slit open along the dorsal mid-line, flattened out, and seen from below. (\times about 3.)

The six chaetae are seen, lettered A-F [*a-f* in the text] on the right side, at their true relative distances. The genital pores, nephritic pores, and tubercula pubertatis (T. P.) are also shown.

in line of *b*. The papilla is oval, and extends outwards nearly to the level of *c*; it is traversed by a spermatic groove, which passes backwards on the next segment, on the anterior margin of which is a depressed, semicircular prominence, in the same line as the porophore. The spermatic groove ceases some distance in front of the chaeta *b*, so that the male pore is close to the anterior margin of segment 18.

The ventral surface of segments 16, 17, 18 is pale yellow, and thus contrasts with the grey tint of the neighbouring segments. On the 18th segment there seems to be an oval glandular area

extending from *b-b*, and in the prechætal portion of the 16th segment a pair of similar glands, which perhaps represent tubercula pubertatis, but they are not well-defined.

The two oviducal pores are visible in the usual segment, in front of the chætal space *a/b*.

The species possesses a single pair of spermathecæ which open between segments 8/9; each pore has a very prominent pale yellowish lip in front and behind, in line *bc*: further, on each of the segments 9 and 10 is a round, pitted tubercle in front of chæta *b* on each side.

The *nephridiopores* are in line *d*.

Dorsal pores are very evident, and commence behind segment 6, continuing to the last segments of the body.

Internal Anatomy.

There are no noticeably stout septa.

The dorsal vessel is double right up to the pharynx (as it is in *Dinodrilus*); the last of the four pairs of hearts is in segment 13, and of considerable size.

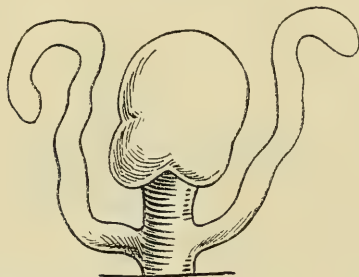
The gizzard is very feebly developed in segment 6; the œsophagus is dilated in segments 14, 15, 16, but no definite gland is formed.

The intestine commences in segment 18.

The worm contrasts with *Dinodrilus* in being meganephric; and in the mid-body, at any rate, the large muscular duct is easily traced, under a dissecting-lens, to the body-wall, which it penetrates in line of chæta *d* to open to the exterior.

The Reproductive system.—There are two pairs of testes and

Text-fig. 47.



Dinodriloides beddardi.—Spermatheca, enlarged.

funnels in the usual segments. The two pairs of sperm-sacs are in segments 11, 12; of small size, and botryoidal (or racemose) in form. There is but a single pair of spermiducal glands, which are thoroughly Acanthodriline in form, each being cylindrical and compactly convoluted to form a mass of considerable size, provided with a short narrow muscular duct.

There are no penial chætæ.

The ovaries are large and occupy the usual segment.

There is a single pair of *spermathecæ* in segment 9; each is a subglobular sac (text-fig. 47) with a muscular duct, narrower than the sac, which does not graduate into it but suddenly diminishes in diameter. Two long tubular diverticula open, one on each side, into the duct close to the body-wall. Each diverticulum, when extended, is about twice the length of the sac.

Remarks.—This genus, as I have remarked above, bears the same sort of relation in regard to the prostates to *Dinodrilus* as *Neodrilus* does to *Maoridrilus*; but in *Neodrilus*, which Michaelsen has termed a “microscolecine form,” the number of testes has also been reduced. Here, however, the reduction does not occur. Moreover, *Dinodrilus* is micronephric instead of meganephric.

We have in New Zealand a series of genera that illustrate the evolution of Earthworms in a very remarkable manner.

Starting with *Notiodrilus*, which on general grounds is considered by Michaelsen as an ancient genus (and herein I agree with him), we have a meganephric worm with 8 coupled chætæ, 2 pairs of prostates opening on segments 17 and 19, while the sperm-ducts open independently on the intervening segment. From this genus several lines of evolution start:—

- (a) *Maoridrilus*—which differs only in having alternately arranged nephridia, opening, that is to say, alternately in relation to the dorsal and ventral couples of chætæ.
- (b) *Neodrilus*—in which the second pair of prostates, second pair of tubes, and spermathecæ have disappeared, but male pore still in the middle of segment 18.
- (c) *Dinodriloides*—in which the number of chætæ is increased to 12 and widely separated, and in which the male pore is close to the anterior margin of the 18th segment.
- (d) *Rhododrilus*—which still retains 8 clusters, but in which the male pore has moved forwards to the 17th segment and opens close to the prostate pore.

Starting again from *Notiodrilus*, we have *Plagiochæta*, which differs from it chiefly in having a considerable number of chætæ; and we readily see how this condition may have come about through a *Dinodrilus*-like form with 12 chætæ. But in this genus *Plagiochæta*, some, like *P. sylvestris*, have meganephridia, others, like *P. rossi*, have micronephridia*.

Once more reverting to our archaic genus, and imagining the development of micronephridia, we reach *Octochætus*, in which the

* See Benham ('02, a). The statement on pp. 287, 289, however, that *P. ricardi* and *P. montana* are similarly micronephric is erroneous. The nephridium is very small in proportion to the size of the worms, and the tubuli of the meganephridium are in tufts, which, under an ordinary dissecting-lens, suggests a series of isolated micronephridia; but in *P. rossi* (laps. cal. *rossii*) the meganephridium has broken up into micronephridia. I am preparing an article on the nephridia of this and other genera of New Zealand Earthworms, and for the present refrain from further detail.

number of chaetae remain normal, though they are differently arranged.

Then there is *Dinodrilus*, with 12 chaetae and micronephridia. But both these genera have the prostate pores and male pores arranged as in the archaic form.

It seems to me that Michaelsen is in error in separating these two genera from other Acanthodriline forms and associating them in a separate subfamily, the Octochaetinae, with *Eutyphaeus* and *Hoplochaetella*; for, apart from the micronephric condition, there is really little to distinguish *Octochaetus* from *Notiodrilus*; moreover their presence in New Zealand indicates their close association therewith. The step from the Acanthodriline series to the Megascolecline is a small one, and appears easily conceivable from analogy with the origin of *Rhododrilus*: that is, one prostate pore has shifted so as to open close to and in common with the male duct in the 18th segment, for several species of Cryptodriline worms have prostates similar to those of *Rhododrilus*.

RHODODRILUS EDULIS, sp. n. (Text-figs. 48-54.)

Two individuals of "Tarao," a worm eaten by the Maoris, were received from Mr. Best preserved in formol.

Dimensions. Length 275 and 285 mm. respectively, with a diameter of .13 mm. just behind the clitellum. The worm is cylindrical, tapering only very slightly posteriorly, and then suddenly decreasing as the anus is approached, so that at segment $n-8$ the diameter is 10 mm., and at $n-2$ it is still 8 mm. The total number of segments in the larger individual is about 300, but as the hindmost segments are very closely contracted and small, and triannulate, it is not easy to count them with absolute correctness—nor does this matter. There is no doubt that the living worm was, when extended, at least 15 inches and possibly more. Mr. Best in a letter says: "These Tarao are small, I have seen them 18 inches in length."

The segments 2-5 are biannulate; 6-12 are quadriannulate, with the chaetae in the third annulus, while those of the clitellar and postclitellar regions are triannulate.

The colour of the "Tarao" is (in formol, which does not cause the colour to change much) red; the anterior end appears pale greyish, much paler than the rest of the body, which is pale reddish, with a tinge of purple on the upper half of the body; the clitellum is buff.

The *prostomium*, like the first segment, is a good deal furrowed; it is epilobic, being dovetailed into the peristomium for about half the length of the latter, and it ends in a transverse groove.

The *chaetae* are eight in number, rather widely spaced; the lateral spaces (*bc*) on each side are nearly equal in the mid-body and posterior region, while the dorsal space (*dd*) is about twice the ventral (*aa*) and three times the lateral.

As is frequently the case in allied genera, the ventral couple (*a, b*) approach one another in the region of the genital pores;

so that, on segment 21, ab is only $\frac{1}{2} ab$ in the mid-body segments, and in the subclitellar segments (*e. g.* 16th) it is even less. At the same time the ventral gap (aa) enlarges, so that b keeps in its line, while a moves outwards. In the preclitellar region this increased gap remains, and the lateral and dorsal gaps are also larger, but the gaps ab and cd remain the same size as in the mid-body; in other words, the rather increased diameter of the preclitellar region affects the interchætal zone, and not the chætal spaces themselves.

I measured the spaces on the body by means of dividers, with the following results:—

	Mid-body.	Tail.	Segment xxi.	Seg. xviii.	Seg. xvi.	Seg. ix.
aa ...	5	4	5.25	6	5.25	5.5
ab ...	3	2.5	1.5	0.75	1	2.5
bb ...	4	3.5	...	...	6.5	5
cd ...	2.5	2.5	...	...	2.5	2.5
dd ...	11	9	...	...	...	12

Put in the usual formula for the mid-body, starting with the smallest gap,

$$cd < ab < bc < aa : aa = 2 cd : dd = 2 aa = 3 bc.$$

On segment 17 the ventral chætae are replaced by two long, delicate penial chætae.

The *clitellum* is saddle-shaped, and though the annuli and intersegmental furrows are quite evident ventrally, there is no distinct latero-ventral margin such as exists in *Lumbricus* &c. The glandular tissue extends down to the line of chæta b . The clitellum extends over the six segments 13–18.

Genital pores, &c.—The male pore is on segment 17, situated on a low, rounded, and slightly prominent porophore in line with the chætal gap ab . The pore itself is nearly in line with b , and the penial chætae project therefrom.

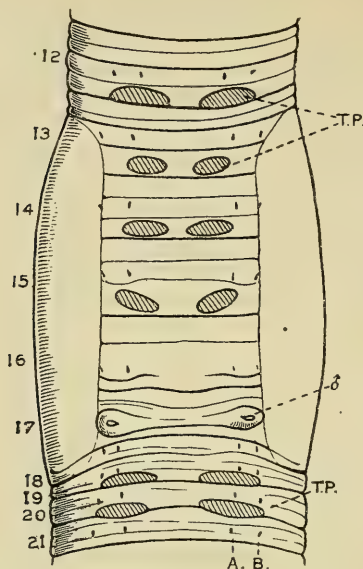
Tubercula pubertatis are well-developed, in the form of a series of transversely disposed, paired oval pads (text-fig. 48, p. 232) situated on the hinder regions of the segments 12, 13, 14, 15, and 19, 20. These pads are developed from the last annulus of the segment in each case, but the last two pairs appear to be intersegmental, owing partly to the contraction of the worm, and partly, perhaps, to their size. These tubercles have not all the same position relative to the chætae: those of the 12th, 19th, and 20th segments extend from the level of b inwards nearly to the middle line, while the other three pairs, on segments 13, 14, 15, extend from chæta a and almost touch in the middle line.

There is a single pair of *spermathecal pores* on the intersegmental groove $7/8$, in line with b . As a matter of fact, each pore is double: *i. e.*, the main sac and its diverticulum open independently one above the other, but close together, in the furrow.

I was unable to detect either dorsal pores or nephridiopores by

examination of the surface, owing to the strongly contracted state of the worm: the nephridiopores, however, are in line *c*.

Text-fig. 48.



Rhododrilus edulis.—Ventral view (\times about 3) of clitellar region, showing male pores (♂) and arrangement of tubercula pubertatis (T.P.); A B [*a b* in the text], the chætal rows. Segment 16 is unfortunately drawn a little too large.

Internal Anatomy.

The body-wall is of great thickness and the septa behind segments 7 to 12 are very stout.

The dorsal vessel is single; the last heart in segment 13, and rather smaller ones in 10, 11, and 12.

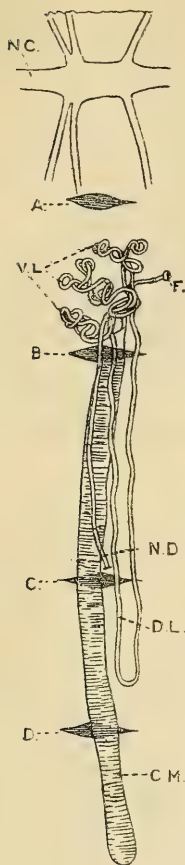
The gizzard, in segment 5, is large, with thick walls, and contains stones. There is no cesophageal gland, nor any dilatation. The intestine commences in the 17th segment, where the gut suddenly enlarges to twice its previous diameter.

The worm is meganephric, and the nephridia commence as far forwards as segment 3. Each nephridium (text-fig. 49) consists of a bunch of 3–5 loops ventrally (situated in line *a-b*), whence a long dorsal loop passes upwards to a point about midway between *c d*, and a straight duct leaves the same bunch, and passes to the body-wall just below *c*, at which point no doubt it opens externally.

There is, in addition, a blind cæcum or bladder with muscular wall, which extends almost to the mid-dorsal line: the exact connections of it I have not determined.

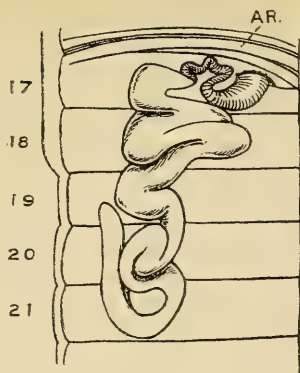
The nephridiostome is small.

Text-fig. 49.



M.L.

Text-fig. 50.



Text-fig. 52.



Text-fig. 51.



Text-fig. 49. *Rhododrilus edulis*.—A nephridium, shown in its natural relation to the wall of the body, as seen when spread out in the normal way. A, B, C, D [*a, b, c, d* in the text], the position of the four chaetae of this side; F, nephrostome; V.L., ventral loops or coils of tubules; D.L., long dorsal loop extending nearly to chaeta D; C.M., muscular caecum; N.C., nerve-cord; M.L., dorsal mid-line; N.D., nephridial duct.

Text-fig. 50. *Rhododrilus edulis*.—The prostate of the left side (enlarged). It occupies five segments and is provided with a muscular duct, which thickens as it penetrates the body-wall just below and behind the arcuate muscles (AR.). The penial chaetal sac has been removed.

Text-fig. 51. *Rhododrilus edulis*.—A penial chaeta ($\times 80$. Zeiss oc. 3, obj. 3, camera.

Text-fig. 52. *Rhododrilus edulis*.—The tip of a penial chaeta ($\times 480$).

Reproductive system.—There are two pairs of large, botryoidal sperm-sacs in segments 11 and 12, attached, of course, to the anterior wall of these segments.

The prostate (text-fig. 50, p. 233) is tongue-shaped, long, more or less convoluted, with apex recurved; it extends through segments 17 to 21; its muscular duct is confined to segment 17; it is rather long, but very narrow where it leaves the gland, dilating to form a thicker, pear-shaped bulb as it penetrates the body-wall.

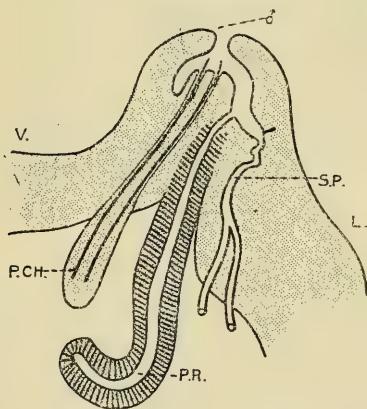
Arcuate muscles are developed in segment 17.

Associated with each prostate are two sacs containing each two penial chaetae, a long functional and a shorter reserve bristle.

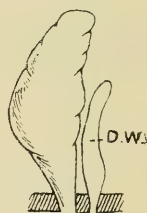
Each penial chaeta (text-figs. 51, 52, p. 233) is stout, nearly straight, and, compared with the size of the worm, not very long: it terminates in a rounded knob, which carries at its end a short, stout, curved, blunt hook. There are no markings at this end; but about midway along its length there is a series of rather closely-set, irregularly arranged, short, oblique, and finely serrated ridges.

The relations of the various parts of the male ducts, as studied

Text-fig. 53.



Text-fig. 54.



Text-fig. 53. *Rhododrilus edulis*.—Diagrammatic sketch of a section through the porophore, showing the openings of the sperm-duct (S.P.), prostate duct (P.R.), and the penial chaetae (P.CH.) into a small antrum or chamber, which communicates with the exterior at the apex of the papilla (♂). The sketch is compiled from a series of sections, and the above pores are not, in reality, in one plane—the prostate pore being most anterior, and the sperm-pore most posterior of the three. V. is the ventral side. L. is laterally placed.

Text-fig. 54. *Rhododrilus edulis*.—Spermatheca ($\times 4$). The main sac, or ampulla, opens externally, independently of the diverticulum (D.W.).

in sections, is as follows (text-fig. 53):—at the apex of the porophore is a small pore, which leads into a shallow, but laterally extended chamber, the floor of which rises up as a papilla. At

the apex of this "penial papilla," as it may be termed, are two independent apertures, belonging to the two sacs of penial chætæ. At the base of this penial papilla, and on the outer side, there opens the muscular duct of the prostate, while the vasa deferentia (which have united) open into a posteriorly placed recess of the above-named chamber. This chamber is very shallow, and we practically have *four* pores on the porophore; and probably in a less contracted condition these four pores would open into a shallow pit, the margin of which has, in our specimen, closed over the pit so as to leave only a single small aperture.

The *spermatheca* (text-fig. 54) lies in segment 8, on each side; it is a large and long sac, broadest in the middle, without a definite duct, but narrowing as it approaches the body-wall. The diverticulum is narrow and tubular, more than half the length of the sac and about one-fourth of its diameter; it opens independently of the sac itself.

As a matter of detail, the length of the main sac is 8 mm., its breadth is 2.5 mm.

Loc. Ruatahuua, Urewera Country, North Island of New Zealand.

RHODODRILUS BESTI, sp. n. (Text-figs. 55-61.)

A very pale, and probably white, worm, with yellow clitellum; its general appearance is that of an *Octochaetus*. A much smaller worm than the preceding, and known to the Maoris as "Tokerangi."

Dimensions. Length 125 mm., diameter 5 mm. just behind the clitellum; with 206 segments, which, with the exception of the first four, are triannulate.

The *chætæ* are spaced, and as measured on the body, $ab=cd$; $bc=aa=1\frac{1}{2} ab$; $dd=2\frac{1}{2} bc$ =about 4 ab . That is, the interchætal spaces on each side are equal and less than the lateral space; the ventral space is less than half the dorsal space. Relatively aa is greater than in the preceding species.

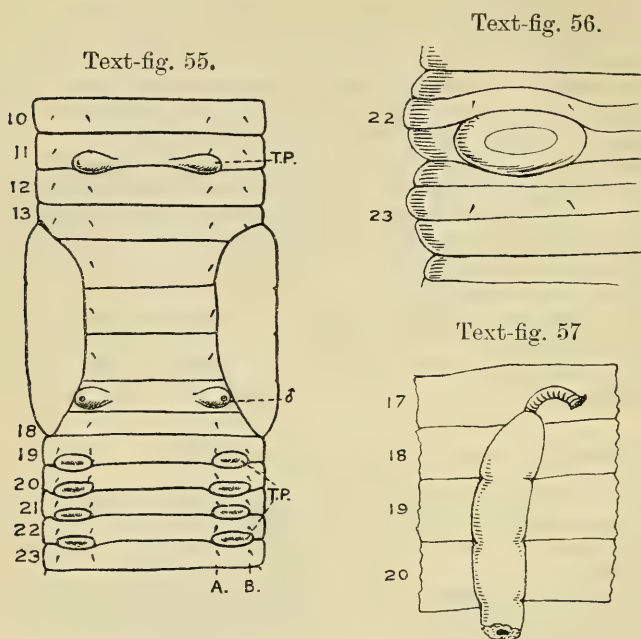
Clitellum saddle-shaped; on segments $\frac{1}{2} 13-18$ ($=5\frac{1}{2}$ segments). The glandular tissue extends downwards as far as line of chætæ a .

Genital pores, &c.—A pair of porophores in segment 17, in line of a : on each, two pores are readily visible under a lens, and the penial chætæ project from the outer one. There are four pairs of postgenital *tubercula pubertatis*, on the posterior annulus of segments 19, 20, 21, 22, in line with the gap ab , the ventral margin extending below a ; so that they are separated by a much greater space than in *R. edulis*. Each *tuberculum pubertatis* is oval, and slightly depressed in its central part, so as to appear sucker-like (text-fig. 56, p. 236).

In addition to these four pairs, there is on the hinder margin of segment 11 a pair of rounder swellings—not pitted apparently—in line with the porophores, and not extending so far outwards

as the postgenital tubercle; further, the pair are connected across the middle line by a transverse ridge.

A single pair of spermathecal pores at the groove 8/9.



Text-fig. 55. *Rhododrilus besti*.—Ventral view of the clitellar segments, &c. (\times about 5), showing porophores and arrangement of the tubercula pubertatis (T.P.).

Text-fig. 56. *Rhododrilus besti*.—An enlarged view of one of the tubercula pubertatis, showing the glandular depression centrally, and also the fact that it is on the hinder annulus of its segment, though apparently intersegmental.

Text-fig. 57. *Rhododrilus besti*.—Portion of prostate, showing shortness of duct, as compared with that of *R. edulis*.

Internal Anatomy.

There are stout septa behind segments 7 to 12. The gizzard is large and occupies segments 5 and 6. The spermiducal glands are long, undulating, tongue-shaped, extending into the 24th segment. The prostrate duct is short, narrow, and only slightly curved (text-fig. 57).

The sacs of penial chætæ extend from segments 17 to 21. Each penial chæta (text-figs. 58–60) is much slenderer than in the preceding species, and larger and of a different form; it is gently curved and the blunt point is bent in the opposite direction; here it is flattened and slightly excavated, so as to be spoon-

shaped when seen from above; in side view, however, the point is narrower.

Text-fig. 58.



Text-fig. 59.



Text-fig. 60.

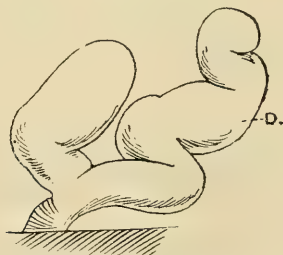


Text-fig. 58. *Rhododrilus besti*.—A penial chaeta ($\times 80$).

Text-fig. 59. *Rhododrilus besti*.—Tip of penial chaeta ($\times 480$). View of one plane, showing spoon-shaped excavation.

Text-fig. 60. *Rhododrilus besti*.—Tip of penial chaeta, side view ($\times 480$), also showing spoon-shaped excavation.

Text-fig. 61.



Rhododrilus besti.—A spermatheca ($\times 12$) (camera outline), showing remarkable coiled diverticulum (D).

The single pair of spermathecae (text-fig. 61) lie in segment 9;

each sac is more or less ovoid, somewhat bent at the commencement of the duct (? perhaps artificially by contraction of the body).

The duct is short, but wide, and receives a very long, tubular diverticulum, which is spirally coiled at its lower end, where it enters the common duct close to the body-wall. The lower end of the diverticulum is muscular, though of the same diameter as the rest.

Loc. Ruatahuua, Urewera Country, North Island, N. Z. A single individual.

Remarks.—It will be seen that this species differs from *R. edulis* in details with regard to the arrangement of chaetae and copulatory tubercles, in form of penial chaetae and spermatheca, as well as in size, form, and colour of the worm itself.

The Genus Rhododrilus.

It is clear that in many features *R. edulis* and *R. besti* agree with *Microscolex*; nevertheless there are certain points of difference, which, in view of geographical distribution, may be of more importance than the resemblances.

For example, most noticeable, but perhaps of no great systematic importance, is the great size of these two species, and especially of *R. edulis* (285 mm.), as compared with the small worms included in the genus *Microscolex*, ranging as they do from a length of 30 mm. to that of 58 mm.

But the point upon which I would lay stress is as to the form and extent of the prostate.

In all the species of *Microscolex* this gland is of comparatively small size, and limited to segment 17, or extends, in *M. hempeli* and *M. novae-zealandiae*, into the next segment; whereas in the two species just described these glands are of very considerable extent, passing through 5 or even 8 segments.

It is also worth noting, in view of the fact that Beddard is inclined to lay some importance on the point in some genera, that in all the species of *Microscolex* the last heart is in segment 12, whereas in my two species it is in segment 13.

Michaelsen points out, too, that in the genus *Microscolex* the single pair of spermathecae open in the furrow 8/9: this is the case with one of my species, whereas the pore in the other is at 7/8.

The gizzard, too, in *Microscolex*, is "absent or rudimentary," which is not true of our edible worms; and, finally, the clitellum of the latter is not "complete" or "girdle-like," but saddle-shaped.

These small points of difference necessitate one of three courses: either we must amend the diagnosis of *Microscolex*, or we must create a new genus, or we may place our species in the closely allied genus *Rhododrilus*. The last plan, it will be seen, is the one I have followed, though even this procedure necessitates the

alteration in the definition of this genus. But this, it seems to me, is a better plan than to modify the diagnosis of *Microscœlex*, for the latter is an American genus, though one species* at least has been recorded from New Zealand; whereas the only species of *Rhododrilus* hitherto described are from this region.

The genus, originally founded by Beddard ('89) for *R. minutus*, has suffered from its resemblance to *Microscœlex*. Originally distinguished from it by its author, as having the prostatic pore separate from the male pore, it was, later, included in that genus, on the discovery that the same arrangement is true of certain species of the older genus. Michaelsen ('00), however, retains it as distinct, owing to the fact that *Rh. minutus* has four pairs of spermathecae.

In 1900 I described a worm from the Chatham Islands as "*Microscœlex huttoni*," with two pairs of spermathecae, following Beddard in disallowing *Rhododrilus*. But since the publication of that article I have studied a species from Campbell Island and the Lord Auckland Group, in which there are three pairs of spermathecae.

Now all these worms agree with the two species described in the present article in having an elongated prostate, extending through several segments, and in most of them the gizzard is well developed; the clitellum saddle-shaped. But the position of the last heart is not constant.

The size of the worms, too, exceeds that of the species of *Microscœlex*.

I therefore agree with Michaelsen to resuscitate Beddard's genus *Rhododrilus* to include our New Zealand worms, but regard the form and extent of the prostate as the chief character, and one that readily distinguishes it from *Microscœlex*.

The characters of the genus as thus modified may be defined as follows:—

Chaetae 8 per segment, more or less widely spaced. Nephridiopores not alternating; male pores on 17; prostatic pores one pair, in 17, opening close to the male pore. Clitellum saddle-shaped, occupying 4 to 6 segments, 13 (14)—(17) 18. A gizzard in 5. Testes two pairs. *Prostates tongue-shaped, elongated, more or less undulatory, extending through 4 to 8 segments.* Penial chaetae present.

Distribution. New Zealand and neighbouring islands,

1. *Rh. minutus*, Beddard, 1889. South Island.
2. *Rh. huttoni*, Benham, 1900. Chatham Island.
3. *Rh. edulis*, Benham, sp. n. North Island.
4. *Rh. besti*, Benham, sp. n. North Island.

I have specimens of other species in my possession of which a description has not yet been published.

* Of a second species, *M. monticola*, our information is not altogether sufficient to permit us to make use of its characters in this discussion.

TOKEA *, gen. nov.

Characters of the genus.—Chætæ 8, spaced, and more or less equidistant; clitellum girdle-like (13) 14—17 (18), *i. e.* covers 4 or 5 segments.

Male pore common with that of prostate, in 18th segment. Two pairs of testes in usual segments; two pairs of sperm-sacs in segments 9, 12; the prostates are long, tongue-shaped, lie below the gut, close to one another, and extend through several segments. No penial chætæ.

The gizzard in 5; no calcareous glands; last heart in 12 or 13. Micronephric, with meganephore in last few segments. Spermathecae two or three pairs, the last in segment 9.

Distribution. North Island, New Zealand.

1. TOKEA ESCULENTA, sp. n. (Text-figs. 62–67.)

This is one of the edible earthworms alluded to in Mr. Best's article as "Kurekure"—as being a specially tasty article of food. As a matter of fact, under this name I find two species recognisable, viz., this and the following.

Mr. Best states that it is "a short red or brown worm about 6 inches in length; found in stony places."

Of this species I received four individuals.

The colour (in formol) is a rather dark purplish-red, paler below; but the pigment extends further round the body than usual; the anterior end is not perceptibly darker; the clitellum is brown.

Dimensions. The largest is, 115 mm. in length; the one studied is 100 mm. \times 6 mm., with 110 segments.

The body is cylindrical.

Prostomium is epilobic, $1/2$; the posterior groove is but feebly developed, but visible when the buccal region is everted.

Chætæ: the 4 on each side are nearly equidistant, and when viewed from above both *c* and *d* are visible; *i. e.* *d* is dorsally placed and *c* is on the lateral line.

In the mid-body $aa = bc = cd > ab$; $dd =$ nearly $2 aa$.

In the preclitellar region the gap *aa* becomes greater and *ab* rather smaller.

Clitellum: this is complete (*i. e.* girdle-shaped) and well developed over the four segments 14–17, where the intersegmental furrows are obliterated. The dorsal surfaces of 13 and 18 are also glandular, but the clitellar colouring is not so definite, and, moreover, the grooves 13/14 and 17/18 are deep.

Genital pores, &c. (text-fig. 62).—There is a pair of male pores in the 18th segment; each is a small pit, in a small, oval, pale spot, and from this small pit a little papilla projects up to the level of the body-wall (text-fig. 63).

This oval poriferous area is in line with *a*.

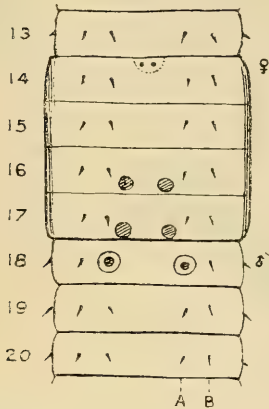
Tubercula pubertatis, in the form of small paired glands, are

* "Toke" is the Maori for Earthworm.

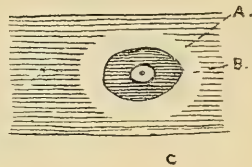
present on the hinder margin of segments 16 and 17, [mediad of the line *a*.

The two oviducal pores are close to the median line, near the anterior margin of the 14th segment.

Text-fig. 62.



Text-fig. 63.



Text-fig. 62. *Tokeia esculenta*.—Ventral view of clitellar region, &c. ($\times 4$), showing male pores and arrangement of tubercula pubertatis and disposition of chaetae. This and the views in text-figs. 68, 70, 73, 76, 78, and 80 are somewhat diagrammatic in that they are represented as flat projections, but the relative spacing of the chaetae, &c., is correct.

Text-fig. 63. *Tokeia esculenta*.—Enlarged view of the male pore, the actual aperture is situated on a small papilla (C) which projects from the bottom of a pit (B), the skin round which is paler (A) than the surroundings. The chaeta *b* is shown on the left side.

There are three pairs of spermathecal pores on the hinder region of segments 6, 7, and 8; these are not intersegmental, but are situated about midway between chaeta *a* and the margin, in each case.

I could not detect dorsal pores.

Internal Anatomy.

There are 8 stout septa, behind segments 7 to 14; but, in comparison with the thickness of the body-wall, their thickness is not so great as one would expect.

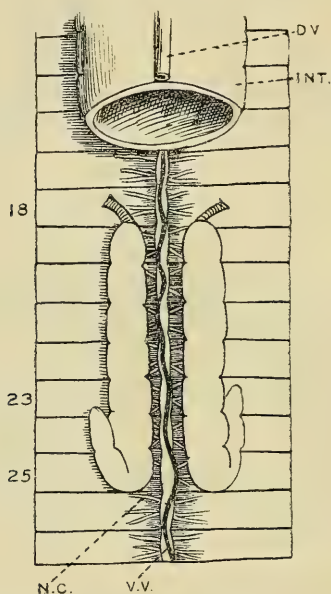
The dorsal vessel is single; the last of the four pairs of hearts is in segment 13. In the heart-segments there is a supra-enteric vessel, with which the hearts are in part connected.

The worm is micronephric*, and these organs commence in segment 3. In the last 20 segments of the body there is, in addition to micronephridia, a pair of compact groups of tubules

* I think this term, which was first employed by Vejdovsky, is preferable to my term "plectonephric," for it is by no means certain that a "network" of tubules always (if ever) exists.

constituting a meganephridium. In these the nephrical funnel is present and can be traced into communication with the nephridium, which opens to the exterior, probably in line with *a*, as it is in another species which was more carefully studied in this respect. I did not trace it in the present species. Not only is there this meganephric nephridiostome in these hinder segments, but a similar funnel is present throughout the worm. In the micronephric segments it is unconnected with the nephridium and has no external opening.

Text-fig. 64.



Tokeia esculenta.—A somewhat diagrammatic drawing of a dissection of the worm, showing the tongue-shaped form and sub-enteric position of the prostates characteristic of the genus; the intestine is cut away exposing the glands; the ventral vessel and nerve-cord remaining *in situ*. INT., intestine; D.V., dorsal blood-vessel; V.V., ventral blood-vessel; N.C., nerve-cord.

The presence of a funnel, independent of the micronephridia, throughout the worm is of very considerable interest. Such an arrangement has not hitherto been recorded. The funnel is of the same size and structure as that of the meganephridia, and both in its large size and peculiar form differs from any funnel hitherto figured. In each of the species of *Tokeia* the same general arrangement occurs, though the details as to character and arrangement and extent of the micronephridial tufts differ in each case. I am preparing a detailed account of the excretory

apparatus of these worms, so that I will not further describe it here.

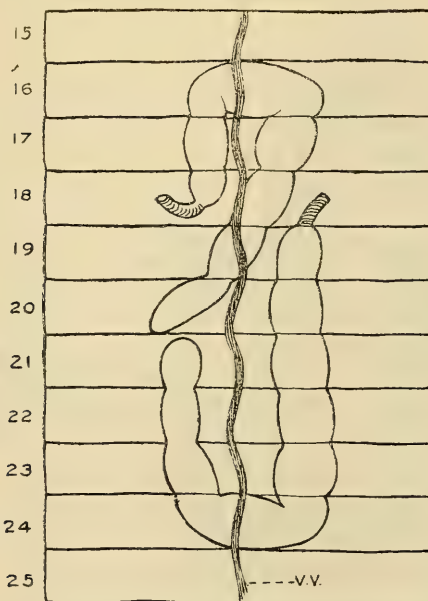
Alimentary system.—The gizzard is small, rounded, and hidden by the extrinsic muscles of the pharynx; it lies in segment 5.

There are no definite cesophageal glands, but in segment 15 the tube is dilated, and its dark vascular wall contrasts with the paler wall of the neighbouring region, and here its lining is thrown into a series of horizontal lamellæ.

The intestine commences in segment 16; there is no typhlosole.

Reproductive system.—The testes and funnels are free and, like the ovaries, lie in the usual segments. The two pairs of sperm-sacs lie in segments 9 and 12: their wall is smooth. Further, on the anterior wall of segment 13 is a minute curved sac, close to the gut, whose curvature it follows; it is of about the same size as a similar sac in the 14th segment, which I take to be the ovisac.

Text-fig. 65.

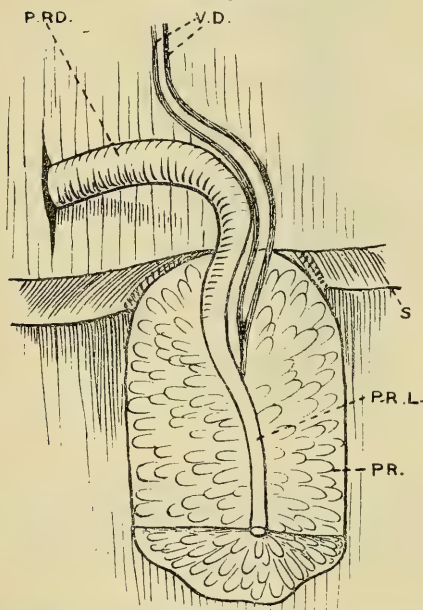


Tokea esculenta.—An asymmetrical arrangement of the prostates, such as occasionally occurs in some species of the genus; V.V., ventral blood-vessel.

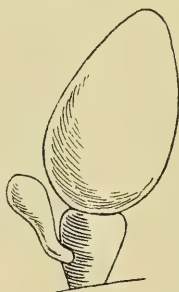
Spencer has noted in some of the Cryptodrilids studied by him such an extra sac in the 13th segment, which he regards as a sperm-sac. I could not discover any developing sperms by teasing this sac on the slide, and I have not yet studied it in sections. I have met with similar structures in some other species.

The prostates have a form and disposition on the body which appear to be peculiar and characteristic of the genus. Each prostate is a long "tongue-shaped" gland (text-fig. 64, p. 242), *i. e.*, though it is tubular in that its axis is hollow, it is not cylindrical but somewhat flattened, extending through several segments, and its apex is usually recurved. The pair of glands, typically, lie side by side, pressed against the body-wall below the gut, and indeed below the ventral blood-vessel; but in individual cases the right and left glands are asymmetrically disposed. For instance, in one case (text-fig. 65, p. 243), the right gland passes backwards from its duct to the 24th segment, and then bends forwards on the left side, and its apex lies in the 21st segment; whereas the left gland passes forwards into the 16th segment, then curves round to the right side, passes at first backwards, and then obliquely to the left side, so that its apex lies in segment 20.

Text-fig. 66.



Text-fig. 67.



Text-fig. 66. *Tokeia esculenta*.—A diagram, compiled from serial sections, showing the course of the sperm-ducts, their union, and junction with the canal of the prostate, well within the region of the glandular tissue. P.R., prostate; P.R.L., its lumen; P.R.D., its duct; S, septum; V.D., vas deferens.

Text-fig. 67. *Tokeia esculenta*.—Spermatheca ($\times 12$. Camera outline of mounted specimen).

The surface of the gland is smooth; it is constricted by the successive septa, and at its anterior end gives rise to a muscular duct which passes to the exterior in segment 18. Sections

through this region of the body show that the two sperm-ducts run back separately along the body-wall as far as the 18th segment, when, meeting the prostate duct, they pass on to its dorsal surface into the 19th segment, and after uniting with one another open into the canal of the prostate gland some distance from the commencement of the muscular duct (text-fig. 66).

The prostate is traversed by a canal lined with columnar cells; at intervals this canal receives small canalicules, around which the gland-cells are grouped and into which they open. The arrangement is similar to that described by Miss Sweet for *Plutellus intermedius* (*loc. cit.* fig. 17).

There are no penial chætæ.

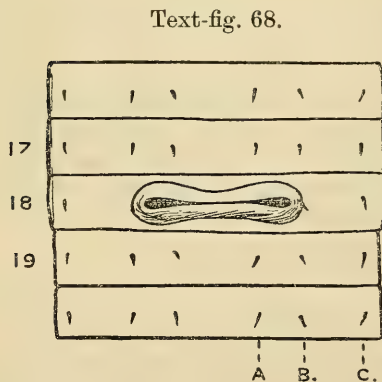
There are three pairs of spermathecae in segments 7, 8, and 9; each (text-fig. 67) is an ovoid sac passing gradually into a short wide duct, which receives the diverticulum close to the body-wall. The diverticulum is a short ovoid body, with duct; it is about $\frac{1}{3}$ the length of the main sac.

The diverticulum of this and the following species is placed mediad of the sac.

2. *TOKEA SAPIDA*, sp. n. (Text-figs. 68 & 69.)

This species is founded on a single specimen of about twice the size of the former species, but included with it as "Kurekure" by Mr. Best.

Text-fig. 69.



Text-fig. 68. *Tokea sapida*, similar view to that in text-fig. 62. ($\times 6$.)

Text-fig. 69. *Tokea sapida*.—Spermatheca ($\times 12$. Camera outline of mounted specimen).

In colour it is purple-red, with an imperfectly developed clitellum of a deeper red than the rest of the body.

Dimensions. 200 \times 8 mm., with 190 segments. The pre-clitellar segments are biannulate.

Chaetae. These are smaller than in *T. esculenta*, and have a different arrangement; for, when viewed from above, *d* is more laterally placed and *c* is not visible. In other words, the dorsal gap (*dd*) is much greater. The formula is:— $ab=cd$; $bc>ab$; $aa=1\frac{1}{2}ab$; $dd=5ab$. I cannot detect any chaetae in front of the 10th segment on examination by a dissecting-lens.

Clitellum: not yet fully developed, as intersegmental grooves are still unobliterated, though the difference in colour is well marked. It is "complete," and covers the five segments 14–18.

Genital pores, &c. (text-fig. 68, p. 245).—On segment 18 is a pale, tumid, transversely disposed ridge, somewhat enlarged at each end: it extends from *b*–*b*, and chaeta *a* appears to be absent. The actual male pore is uncinuate, and on the mesial side of *b*, but close to it. No *tubercula pubertatis* are present. The three pairs of spermathecal pores are at 6/7, 7/8, 8/9, in line with the gap *ab*.

Internal Anatomy.

There are eight stout septa, behind segments 6–13, but the first and last are less stout than the others.

The last heart is in segment 13.

The gizzard, in segment 5, is of large size; the oesophagus presents no dilatation.

The nephridia have the same general arrangement as in *T. esculenta*.

The genital organs agree on the whole with the latter species; but in the single individual in my possession the prostates are asymmetrically arranged, viz., the left gland extends back to segment 23, and then bends forwards and ends in the 23rd segment. But the right gland is bent in an S-shaped manner, and lies wholly in segments 18, 19, and 20; but, as in the preceding species, both are pressed against the body-wall.

The spermathecae, in segments 7, 8, 9, differ in shape from those of *T. esculenta*; the diverticulum (text-fig. 69, p. 245) being globular, with a short duct, opening into the spermathecal duct close to the body-wall.

Loc. Ruatahuua, North Island, New Zealand.

3. TOKEA UREWERE, sp. n. (Text-figs. 70–72.)

This worm is known to the natives as "Pokotea," and is described by Mr. Best as "a short white worm." I received three specimens, which in formol are quite a pale pinkish brown, paler still behind the clitellum, which is orange or orange-brown, with a dusky anterior margin.

Dimensions. 65 to 80 mm. in length, with a diameter of 7 or 8 mm.; there are 78 segments in the larger individual. The segments are not annulated.

The *prostomium* is $\frac{1}{2}$ epilobic; without a transverse furrow.

The *chaetae* have the same general arrangement as in the

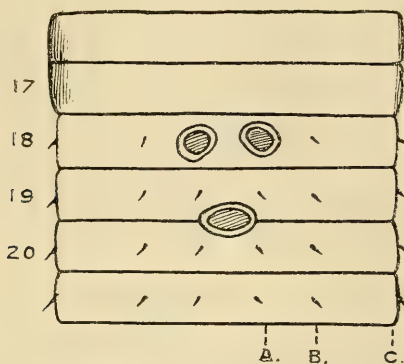
preceding species; when viewed from above *d* is dorsally and *c* laterally placed, but in the tail the line *c* approaches *d*.

$aa=ab=cd$; $bc>ab$; $dd>bc$. But the differences, measured in millimetres, are very slight: thus $aa=2.5$; $bc=3$; $dd=4$.

The *clitellum* is well marked, complete, and covers the four segments 14–17; but the ventral surface of the last segment is less glandular than the rest.

Genital pores, &c. (text-fig. 70).—On segment 18 is a pair of subcircular depressions, with a distinct, slightly raised margin; this is in line *a*.

Text-fig. 70.



Tokea urewera, similar view to that in text-fig. 62. ($\times 6$)

There is a single, median *tuberculum pubertatis*, in the form of an oval, glandular, depressed area, extending from *a-a*, between segments 19/20.

The three pairs of spermathecal pores are in line *a*.

Internal Anatomy.

The seven septa behind segments 6 to 12 are only slightly thicker than the following.

The last heart is in segment 12.

The micronephridia are more delicate than in the preceding species, and do not form so dense a covering to the body-wall.

The meganephridia are confined to the last 12 to 15 segments.

The gizzard (in segment 5) is longer than in *T. esculenta*, though not so wide.

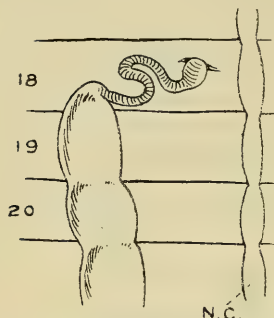
The oesophagus is more or less dilated in segments 11–15; and in the first two of these the thick vascular wall is provided with lamellæ internally.

The prostates extend back to the 26th segment; the muscular duct is long, narrow, and more or less undulating, becoming thicker where it dips into the body-wall.

The three pairs of spermathecae are in segments 7, 8, 9; each sac is ovoid (text-fig. 72), and the duct is much narrower than the sac; the diverticulum is small, and also has a narrow duct.

Loc. Ruatahuua, North Island, New Zealand.

Text-fig. 71.



Text-fig. 72.



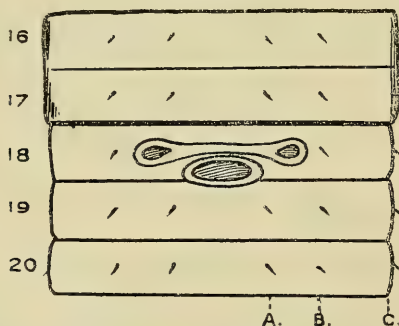
Text-fig. 71. *Tokea urewera*.—View of the anterior end of the prostate, showing the long, narrow and undulating duct. N.C., nerve-cord.

Text-fig. 72. *Tokea urewera*.—Spermatheca ($\times 12$. Camera outline of mounted specimen).

4. *TOKEA HUTTONI*, sp. n. (Text-figs. 73–75.)

A single individual collected by Capt. Hutton; it is much bleached, but was apparently purplish.

Text-fig. 73.



Tokea huttoni, similar view to that in text-fig. 62. ($\times 9$.)

Dimensions. 80×5 mm., with 63 segments; but possibly imperfect*.

Prostomium $\frac{1}{3}$ epilobic; segments of body not annulated.

* On opening the tail, I find no meganephridia; perhaps the true hinder end had been severed and the wound healed. The lining of the intestine was continuous with body-wall round anus, but this region was thin.

Chaetae: when viewed from above, both *c* and *d* are on the dorsal surface, and *c* is well above the lateral margin.

$aa = bc = cd$; $ab < bc$; $dd = 2b > bc$.

The *clitellum* is fully developed, complete, and includes segments 14 to 17; but both the 13th and 18th segments are glandular on the dorsal surface, the furrows 13/14 and 17/18 are, however, quite deep, whereas the intervening ones are obliterated.

Genital pores, &c. (text-fig. 73).—In segment 18 is a slight circular depression with raised margin, in line with the gap *ab*; the chaeta *a* appears to be absent. There is a single median, oval *tuberculum pubertatis* on the hinder margin of the 18th segment, extending from *a-a*.

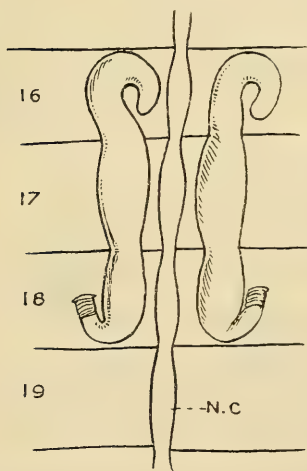
The three pairs of spermathecal pores are on the hinder margins of segments 6, 7, 8, in the gap *ab*, though nearer to *a* than to *b*.

Internal Anatomy.

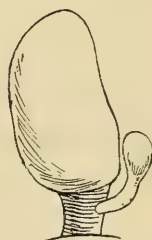
There are seven thickish septa behind segments 7–13.

The last heart is in segment 12.

Text-fig. 74.



Text-fig. 75.



Text-fig. 74. *Tokea huttoni*.—View of the prostates, which, though symmetrical, have assumed a reversed position (? abnormal), with the anterior end directed forwards. N.C., nerve-cord.

Text-fig. 75. *Tokea huttoni*.—Spermatheca ($\times 12$. Camera outline of mounted specimen).

The gizzard is long, narrow, and the wall rather thin.

The micronephridia form a pretty close felt over the body-wall, and commence (as in other species) in segment 3.

The prostates (text-fig. 74) are shorter than in either of the preceding species, and both are directed forwards, but lie side by

side below the gut. They only extend through the three segments 18, 17, and 16.

The duct is very short and thick.

The spermatheca (text-fig. 75, p. 249) likewise has a short duct, and the diverticulum is similar to that of the foregoing species.

Loc. Whangarei, North Island, New Zealand.

Remarks.—This species is evidently nearly allied to *T. urewerae*, but differs from it in the relative position of the male and spermathecal pores, in the position of the *tubercula pubertatis*, in the chaetal formula, and especially in the relation of *ab* to *bc*, as well as in the less extent of the prostate and its duct.

5. *TOKEA SUTERI*, sp. n. (Text-figs. 76, 77.)

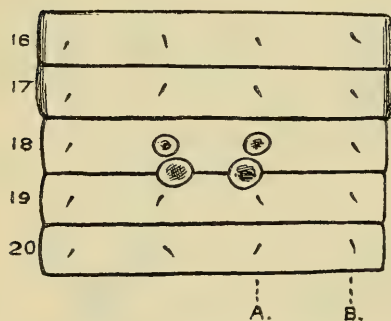
A single individual collected by Mr. H. Suter in 1899. It differs in general appearance from any of the preceding species, not only in size, but in colour. It is dark purplish brown throughout the entire dorsal surface; the clitellum is reddish purple.

Dimensions. 50 × 5 mm.; with 86 segments.

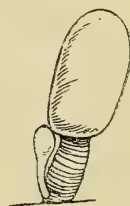
Prostomium $\frac{1}{3}$ epilobic; without transverse groove.

The *chaete* are practically equidistant, i. e. $aa = ab = bc = dd = 2$ mm., while *cd* is only 1.75 mm.

Text-fig. 76.



Text-fig. 77.



Text-fig. 76. *Tokea suteri*, similar view to that in text-fig. 62. ($\times 9$)

Text-fig. 77. *Tokea suteri*.—Spermatheca ($\times 12$. Camera outline of mounted specimen).

On the clitellum the gap *aa* is a little less than posteriorly, and in the preclitellar region still less; the gap *ab* is less in the clitellar region, but not anteriorly. But these differences are not perceptible till measured with compasses.

Clitellum in segments 13–17 (= 5 segments), girdle-like.

Genital pores, &c. (text-fig. 76).—A pair of small papillae on segment 18, in the line of *a*.

There is a pair of small *tubercula pubertatis*—subcircular and pitted—between 18/29 in line *a*, and extending further mediad thereof than do the porophores.

The three pairs of spermathecal pores are in line *a*, at 6/7, 7/8, 8/9.

Internal Anatomy.

There are five slightly thickened septa, behind segments 8 to 12.

The last heart is in segment 12.

The gizzard is feebly developed; its wall is not thicker, though tougher, than that of the œsophagus.

The prostates are quite typical, and extend back to segment 23, with tips recurved; the duct is short and narrow.

The spermatheca (text-fig. 77) has a long duct, with a long narrow diverticulum opening into it at the body-wall.

Locality. Auckland, New Zealand.

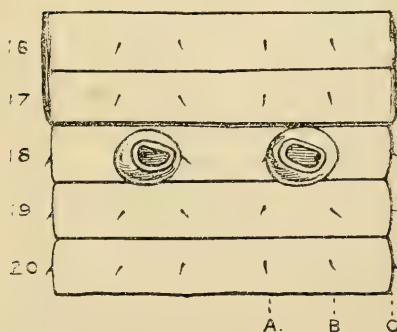
Remarks.—Anatomically there is a rather close resemblance between this and the two preceding species; but in the coloration and dimensions it is remarkably distinct, while the practical equidistance of all the 8 chaetæ, the paired *tubercula pubertatis*, and the details as to the prostate and septa, mark it off as distinct.

6. *TOKEA KIRKI*, sp. n. (Text-figs. 78, 79.)

Five specimens collected by Professor H. B. Kirk, in 1902, are about the same size and colour as *T. esculenta*, *i. e.* reddish purple, but rather paler than the latter; the pigment extends further round to the ventral surface than is usually the case, and ceases about the level of *b*.

The clitellum is brownish red.

Text-fig. 78.



Text-fig. 79.



Text-fig. 78. *Tokea kirki*, similar view to that in text-fig. 62. ($\times 7$.)

Text-fig. 79. *Tokea kirki*.—Spermatheca ($\times 12$. Camera outline of mounted specimen). This has no muscular duct distinct from the sac.

Dimensions. The length varies from 80 to 100 mm., with a diameter of 6 mm. for 110 segments in the larger individuals.

The *chaetæ* are practically equidistant; but on measurement it is found that $ab=bc=cd$ ($=1.75$ mm.), while $aa=dd=2$ mm.

When viewed from above, *d* is dorsally placed and *c* rather above the lateral margin.

The *clitellum* is not fully developed on any of the specimens, as the intersegmental furrows are distinct; but the characteristic coloration extends over the five segments 13 to 17.

Genital pores, &c. (text-fig. 78, p. 251).—The male pores are situated in what appears to be a pair of *tubercula pubertatis* on segment 18; there is a very large, broad, subcircular papilla on each side, extending from nearly *a* to *c*; this carries a somewhat quadrangular depression surrounded by a distinct rim or margin; this depression is glandular and has all the characters of a *tuberculum pubertatis* (as seen in section); and the male pore is quite small and situated in the outer edge of this gland, just within the margin, *i. e.* nearly in line *b*. The two oviducal pores are situated close together, in a pale area, near the anterior margin of segment 14.

There are only two pairs of spermathecal pores, situated at 7/8, 8/9.

Internal Anatomy.

There are no specially thick septa.

The last heart is in segment 12.

The gizzard is quite small; the *œsophagus* is very much dilated in segment 14, but there is no constriction separating it from the canal; its lining, however, is thrown into a series of horizontal, lamelliform folds.

The micronephridia, instead of being spread over a great part of the body-wall, in each segment, form a very distinct and narrow row close to the septa.

The prostates extend from the 18th to 23rd segments, and each is provided with a narrow duct.

There are two pairs of spermathecae in segments 8, 9; each (text-fig. 79) is a somewhat pyriform sac, without a distinctly marked duct; the diverticulum is of the same shape, and also without definite duct.

Locality. Ohaeawai, North Island, New Zealand.

Remarks.—A very distinct species, characterised both by the remarkable coincidence of male pore and copulatory tubercle, and by the possession of only two pairs of spermathecae.

7. *TOKEA MAORICA*, sp. n. (Text-figs. 80–82.)

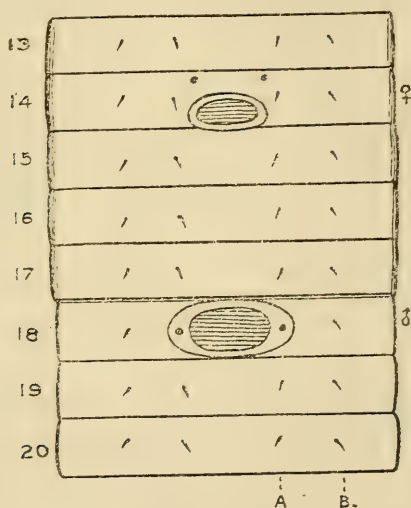
I have eight specimens of this species, collected at different times by Mr. H. Suter, at different places in the neighbourhood of Auckland. The colour is a dark purplish brown, more brown than purple in these alcohol specimens, and resembles that of *T. suteri*. The *clitellum* is paler brown; the chaetae are inserted in white spots, as in *Plagiochaeta sylvestris*, to which also they bear a resemblance both in colour and their short, stout form; indeed, from a hasty first glance, I had placed them with the latter genus, awaiting examination.

Dimensions. The largest specimen measures 70×4 mm., and consists of 75 segments; the shortest mature individual measures 25×2 mm., and likewise consists of 75 segments; and the same number occurs in a worm of intermediate size.

We have here an instance—unique, so far as I am aware—of an earthworm increasing in length without adding new segments posteriorly. It is true that we do not know much on this subject; but the accepted view is that the number of segments is continually added to during growth.

With regard to this, Beddard ('95, p. 2) states:—"There are at present no exact data as to the constancy of the number of segments among Earthworms. In all probability the number is not absolutely fixed, but there appears to be a mean for each species round which there is a certain amount of variation."

Text-fig. 80.



Tokea maorica, similar view to that in text-fig. 62. ($\times 11$.)

Prostomium $\frac{1}{2}$ epilobic; without a transverse groove.

Chaetal formula:— $ab < cd < bc$; $bc = 2 ab = aa$; $dd = 2 aa$.

Clitellum girdle-like, over the five segments 13 to 17.

Genital pores, &c. (text-fig. 80).—On segment 18 is a transverse, elliptical area, paler than its surroundings; glandular centrally, with a distinct margin surrounding it. It extends between points a little outside *a*, on each side. This is a *tuberculum pubertatis* (text-fig. 81, p. 254), and the male pore is situated on the thickened margin, at each pole of the ellipse in line with *a* (which is absent in this segment). There is a second *tuberculum pubertatis* of the same shape, but of much smaller size, on the hinder border of

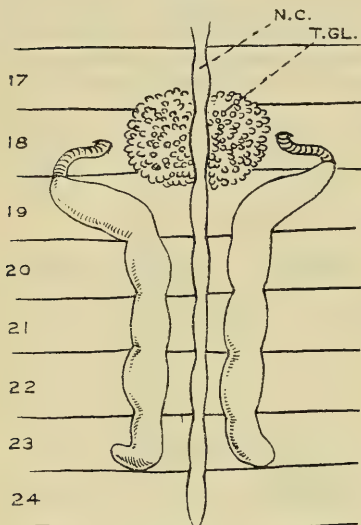
segment 14, and not quite reaching the line of *a* on either side. This tubercle is absent in some individuals.

The oviducal pores are wide apart, nearly in line of *a*, but a little mediad.

The two pairs of spermathecal pores are distinct and slit-like, about midway between the chaeta *a* and the posterior margin of each of the segments 8, 9.

Dorsal pores are present, at least in the postclitellar region.

Text-fig. 81.



Text-fig. 82.



Text-fig. 81. *Tokea maorica*, the prostates and the gland of the *tuberculum pubertatis* (T.G.L.).

Text-fig. 82. *Tokea maorica*.—Spermatheca ($\times 12$. Camera outline of mounted specimen).

Internal Anatomy.

The last heart is in segment 12.

The gizzard, though small, is distinct.

The micronephric tubercles are more delicate than in other species, and all concentrated to form a latero-ventral mass on each side.

The prostates extend back to segment 23; the duct is narrow and rather long, and between the pair of ducts lies a great glandular mass, which thrusts the anterior ends of the prostates outwards, so that the duct is transverse.

Each of the spermathecae (text-fig. 82), in segments 8 and 9, consists of a pyriform sac with a very thick duct, thicker than the neck of the sac. A small tubular diverticulum, dilated terminally, opens into the duct near the body-wall.

Localities. Auckland : Waitakerei Bush and Nikau Palm Bush (near Auckland); North Island, New Zealand.

Remarks on the Genus Tokea.

The distribution of the seven species attributed to this genus extends over a considerable portion of the North Island of New Zealand, for the localities from which specimens have been collected are widely separated and cover more than three degrees of latitude, the most northerly spot being Ohaeawai, practically in latitude 35° south, and the most southerly spot, Ruatahuua, is south of 38°.

The really striking fact illustrated by these seven new species is the presence in the North Island of New Zealand of a Cryptodriline genus as an important, and apparently predominating, element in the Earthworm fauna.

Hitherto, as I have remarked, our knowledge of this fauna in New Zealand has been derived from a study of the South Island representatives, and here the predominating element is the Acanthodriline series.

This was recognised some years ago by Beddard, who in his 'Monograph' (p. 154) says :—"New Zealand is essentially different from Australia. The prevalent forms in Australia are Perichatidæ and Cryptodrilidæ; the most abundant worms in New Zealand are Acanthodrilidæ."

I have, in my Presidential Address to Section D of the Australian Association for the Advancement of Science ('02, b), dealt with this difference very fully, and little thought that the North Island would present so different a set of Earthworms.

Beddard, indeed (1890, p. 285), suggests that "the North Island may prove to be more 'Australian' in its character when it comes to be known"; but the grounds for this statement at that time seem to have been very slender, for only one worm had been recorded from that island, viz. Schmarda's "*Hypogoeon orthostichon*," of which nothing was known beyond the few facts of its external appearance recorded by that zoologist, and sufficient of its internal anatomy noted by Beddard to indicate its Cryptodriline affinity. So characteristic, indeed, is the Acanthodriline group of worms, that doubt has been thrown upon the occurrence of this species in New Zealand. Captain Hutton ('79) doubted it on geographical grounds, for Schmarda gives the locality as "Mount Wellington, New Zealand"; and Hutton, knowing that there was no mountain of any size called by this name in New Zealand, stated that probably some confusion with "Mt. Wellington," Hobart, Tasmania, had crept into Schmarda's notes. In my Presidential Address, I omitted it entirely from the list of earthworms occurring in this Colony, and even so far as to read a note ('02, c) attributing it to Tasmania. But, in view of the undoubted occurrence of Cryptodriline worms in New Zealand, this doubt is itself rendered somewhat doubtful and

possibly premature. No such mountain occurs on ordinary maps of New Zealand as "Mt. Wellington," and I therefore consulted Prof. H. B. Kirk, who has an extensive first-hand knowledge of the geography of the North Island: in response to my query, he informs me that "Mt. Wellington is one of the small volcanic cones just out of Auckland. It is, now, under grass, and is in a fully cultivated district."

The geographical doubt is thus set at rest; for Schmarda visited Auckland, and at that period (1860, about) it is probable that little or no cultivation had then been carried on this small mountain; and, in light of these new observations of mine, it seems that we must now admit into our fauna Schmarda's species.

Our knowledge of its internal anatomy is due to Beddard ('92), who recognised that it belonged to the genus *Megascolides*, as he understood it, but by Michaelsen it is placed in Fletcher's genus *Notoscolex*; but as we did not know the condition of the nephridia in the posterior end of the body, it is impossible to be sure of the correctness of the genus. (See later.)

N. orthostichon appears—from the necessarily brief account given by Beddard—to differ from the species of *Tokea* only in the size of the prostate, which that zoologist states is "short and tubular." He says nothing as to whether it is confined to one segment or extends beyond it; but presumably it does not exhibit the characteristic disposition found in *Tokea*, though, as we see, in *T. huttoni* this gland is "short" as compared with its length in the other species, as it only traverses three segments.

It is remarkable, however, that it differs from all the other species of *Notoscolex*, in which the clitellum covers fewer than ten segments, and in which the arrangement of the chaetae is unchanged at the posterior end of the body (Michaelsen, '00), in that the chaetae are equidistant (*i. e.* the formula is $ab=bc=cd$), as is the case with several of my species; and if we suppose that it does belong to the same genus as do the seven new species herein described, it might be suggested that one or other of the latter is identical with *N. orthostichon*, especially as I have obtained two species from Auckland.

Let us, then, examine such characters which appear to be specific as Beddard mentions. Firstly, it has two pairs of spermathecae, in which it agrees with *T. kirki* and *T. maorica*—the latter of which came from the Auckland district. The other Auckland species, *T. suteri*, is out of court, as it possesses three pairs of spermathecae. The two species to which it presents this resemblance have very different forms of spermathecae. Unfortunately, Beddard's description is too meagre to allow us to judge whether in *N. orthostichon* the organ resembles either of them; for, he says, "each [spermatheca] has a small diverticulum, pyriform in shape like the main pouch." Such a general description applies to several of the above species.

Now, in *T. maorica* the duct of the spermatheca is very wide;

and if such a duct exists in *N. orthostichon*, it seems unlikely that it would have escaped Beddard's notice. Moreover, in *T. maorica* the chaetal formula is different, whereas in *T. kirki* it is similar to that of *N. orthostichon*, and the spermatheca is without a distinct muscular duct. The only other characters are the extent of the clitellum and its size.

Beddard gives the former as occupying segments 14 to 17 inclusive, whereas in my species it begins at segment 13; and as to size, Schmarda gives it as 80 cm. \times 4 cm., with 60 segments—distinctly smaller than *T. kirki*, though approximately that of *T. maorica*.

It appears, then, to be distinct from either of the two species possessing only two pairs of spermathecae; for, apart from any similarities, the prostate in those two species is of considerable length. But it agrees more closely with *T. huttoni*, in size, in chaetal formula, extent of clitellum, and small size of prostate; but in that species there are three pairs of spermathecae.

So far, then, as our information allows us to judge, Schmarda's species is distinct from any of those described in the present paper; and we have not sufficient information to allow us to say definitely that it even belongs to the genus *Tokea*, although it appears not improbable that it does so; but Beddard states that the sperm-sacs number three pairs, and occupy segments 10, 11, 12—an unusual arrangement, even in *Notoscolex*, where 11, 12 is the more general position.

Remarks on the Genera Megascolides and Notoscolex.

It is very evident that this new genus *Tokea* is nearly allied to the Cryptodriline genera *Megascolides* and *Notoscolex*; but it appears to me to differ in details from either of them. It is notoriously difficult to define these Australian genera; and it is unfortunate that the opinions of our two leading systematists, Beddard and Michaelsen, are absolutely at variance as to the characters and limitations of the genus *Megascolides*.

This name was given by Prof. M'Coy in 1878 to a worm, *M. australis*, which, at a later period, received full anatomical treatment at the hands of Baldwin Spencer (1888); and this it is which Michaelsen (1900) takes as the type of the genus, of which he gives this diagnosis (p. 182, translation): "Eight chaetae; clitellum beginning at or before segment 14 and extending over 6 to $9\frac{1}{2}$ segments. One pair of female pores; spermathecal pores 2 to 5 pairs, the last being on 8/9. Gizzard 5 or 6, or 5 and 6. Excretory organs consist of diffuse nephridia, to which is added a pair of meganephridia in each of the posterior segments. Prostate tubular (sometimes lobate)." (Italics are Michaelsen's.)

It will be seen, then, that in some of the above characters the new genus agrees with *Megascolides*, and notably in the co-existence, in the hinder segments, of meganephridia with micro-

nephridia. But it differs in that the clitellum in my new species is less than that characteristic for the above.

The only difference between *Megascolides* and *Notoscolex* upon which Michaelsen lays special stress is the presence of meganephridia posteriorly. The diagnosis of the latter genus he gives (p. 187) as: "Chætæ 8. Clitellum, beginning at or before segment 14, extends over $3\frac{3}{4}$ to $10\frac{1}{2}$ segments. The female pores are usually 1 pair, seldom unpaired [median]. *Spermathecal pores* 2 pairs in the intersegmental furrows 7/8.8/9; rarely shifted backwards on to the 8th and 9th segments. One gizzard in 5 or 6. *Plectonephric*; nephridia diffuse. Prostate usually lobate, sometimes tubular." (Italics are Michaelsen's.)

The two distinguishing characters, then, are the limited number of spermathecae and the diffuse nephridia, without the posterior meganephridia. It is unfortunate that in a considerable number, perhaps the majority, of the species included in *Notoscolex* the condition of the posterior nephridia is unknown.

If, then, we depend on these formal diagnoses, we should no doubt refer my new species to the genus *Megascolides*, especially if they had been found in Australia.

On examining the anatomical details of the only species of *Megascolides* the anatomy of which is thoroughly known, viz. *M. australis*, we note several differences from *Tokea*; amongst others:

- (a) The chætæ are in couples, all ventral.
- (b) The prostates are compactly coiled, cylindrical tubes, similar in general shape to those of true Acanthodriline worms; they are, too, situated laterally, and confined to segment 18.
- (c) The sperm-ducts open into the duct of the prostate in the substance of the body-wall; which is also the case in the only other species of the genus that has been investigated by means of sections, viz. *M. illawarrae* (see Sweet, p. 113).
- (d) The spermatheca has quite peculiar rosette-shaped diverticula.

But the above statements do not apply to each of the other three species included in the genus; for the prostates are flattened and more or less lobate; the spermatheca in *M. cameroni* is similar to that of many other Cryptodriline species. Nevertheless, in all of them the chætæ are distinctly coupled; *i. e.*, the spaces *aa* and *bc* are greater, much greater in some cases, than *ab*, whereas in *Tokea* these spaces are more or less equal and the "coupling" is quite unnoticeable. It is not probable that any of these characters by themselves are of generic value. And, as a matter of fact, when we come to look into the anatomy of these four species we find numerous differences—which, in the case of other genera, Michaelsen has considered as of sufficient importance to deserve generic rank. I refer, for instance, to the fact that *M. insignis* and *M. cameroni* have only one pair of testes, and this in segment 11. But it is clear that the only characters

which these four species have in common, and in which they agree with *Tokea*, is the coexistence in the posterior segments of meganephridia and micronephridia.

Let us turn to Beddard's conception of the limits of the genus *Megascolides* (= *Notoscolex* Fl.) and *Cryptodrilus* Fletcher (the history of which is well given in his Monograph, pp. 445 *et seq.*). He draws attention to the fact that in nearly all the worms described by Spencer, and in a considerable number of those described by Fletcher (at any rate in such cases in which sufficient information is given to enable a comparison to be made), there is a correlation between certain of the internal organs (p. 447), viz. that "they have either (1) paired nephridia, tubular spermiducal glands, and last pair of hearts in the 12th segment; or (2) diffuse nephridia, lobate glands, and last heart in the 13th segment." He decides to regard those species with the first set of characters as belonging to the genus "*Megascolides*," and those with the second group as "*Cryptodrilus*." He admits that there are exceptions to these correlations.

It thus comes about that Michaelsen uses the generic name *Megascolides* for "micronephric," whereas Beddard employs the same name for "meganephric" worms. But the meganephric species are placed by Michaelsen in the genus *Plutellus*, which is thus extended to include species previously attributed to *Argilophilus* of Eisen, *Megascolides* of various authors, *Cryptodrilus* of Fletcher, as well as *Plutellus* of Perrier and Benham.

Thus we have this unfortunate confusion in the employment of generic names:—

- Megascolides* M'Coy, in Michaelsen's sense,
 = *Notoscolex* (part) Fletcher,
 = *Cryptodrilus* (part) Beddard;
Notoscolex Fletcher, as used by Michaelsen,
 = *Notoscolex* Fl. + *Cryptodrilus* Fl.
 = *Megascolides* (part) Spencer;
Cryptodrilus, in Beddard's sense,
 = *Cryptodrilus* Fletcher,
 = *Megascolides* (part) Spencer,
 = *Notoscolex* (part) Fletcher;
Megascolides, in Beddard's sense,
 = *Cryptodrilus* (part) Fletcher, Spencer,
 = *Megascolides* (part) Spencer,
 = *Argilophilus* Eisen,
 = *Plutellus* Perrier.

It is natural that in a group like Earthworms a mixture and confusion of this sort is likely to arise as knowledge advances; and it remains for Prof. Baldwin Spencer with the large stock of material in his possession, to endeavour to find some more satisfactory method of discriminating between genera than those usually employed.

Of course the correct name that should be applied to the genera

depends on the law of priority; and there can be little doubt but that *Megascolides australis* is the "type" of *Megascolides* McCoy; but it does not seem quite so clear as to whether the word *Notoscolex* or *Cryptodrilus* should be retained to apply to the other genus. But this thorny matter of nomenclature I regret that I have not time to discuss thoroughly.

Having thus cleared the ground, satisfactorily as it seems, of the meganephric species, there remain the large series of micro-nephric species to be dealt with; and it becomes a question whether Michaelsen's characters are good, viz.:

- (a) Absence or presence of meganephridia posteriorly; and
- (b) A limited number (two pairs) or a greater number (up to five pairs) of spermathecae.

In regard to the first, it is admitted that in many species we are ignorant as to whether the large nephridia are or are not present.

In the second case, in other genera—e. g., *Pheretima* and *Megascolex*—the number of spermathecae has not been used as a generic character*.

Since, therefore, the seven species of New-Zealand worms here described agree very closely with one another, and except in one respect differ from those species referred to *Megascolides* by Michaelsen, and since, too, I am not in a position to rearrange the generic characters of these allied genera, it seems to me better to erect a new genus. It may be that it is only of subgeneric rank; but for the present less confusion will arise, I think, if we regard it as a distinct genus.

The genus *Tokea* differs from *Megascolides*, as defined by Michaelsen, in the following points:—

- (a) The limited extent of the clitellum, in which only 4 or 5 segments are involved, whereas his minimum is six.
- (b) The widely separated chaetae, of which the coupling is not recognisable.
- (c) The form and position and size of the prostate.
- (d) The position of the point of entrance of the sperm-duct into the prostate-duct.
- (e) The existence throughout the body of nephridial funnels, although in the greater part of the worm these have no connection with the nephridia.

These are truly small points of difference on which to form a new genus; but not smaller than that on which *Megascolides* is distinguished from *Notoscolex*, viz., the presence in the former of meganephridia in the hinder segments of the body†. In my opinion, this is by no means a good line of distinction; and even

* The same remark applies to the position of the last heart, utilised in diagnosing the genera by Beddard; for in *Plagiochaeta* and *Octochaeta*, as in *Tokea*, we find species in which it is in the 12th, and others in which it is in the 13th segment.

† Or, *Macridrilus* from *Notodrilus*, in having nephridiopores alternate, instead of in line

the separation of *Plutellus* from these two genera, merely on account of the presence of meganephridia only depends on a point quite as small.

I have already described a species of *Plagiochaeta*, viz. *Pl. rossi*, in which micronephridia replace the meganephridia of the other half-dozen species; and embryology has taught us that the one is derivable from the other condition—that, at any rate in the genera *Megascolides* (Vejdovsky) and *Megascolex* (Bourne), the earlier meganephridium breaks up into numerous micronephridia.

Is not the separation of the genera according to the condition of the excretory system a remnant of my own unfortunate attempt to classify the families of Earthworms into “Plectronephrica” and “Meganephrica”?

But without entering upon the laborious task of essaying to rearrange the “Cryptodriline” genera, I will express the opinion that a careful study of the form and structure of the prostate (together with other characters) may be more likely to lead us in the right direction. And, firstly, it seems to me profitable to distinguish the “tubular”-*cylindrical* prostate, such as occurs in *Megascolides ambialis*, from the flatter, elongated “tongue-shaped” form of gland that occurs in *Tokea*, some species of *Plutellus**, and others, and the “flattened, lobed, and compact” organ characteristic of such genera as *Pheretima* and *Megascolex*. That these may form a developmental series, Miss Sweet’s work (1900) has rendered probable; but they also appear to have structural differences that may turn out to be of diagnostic character. At any rate, they are easily recognised macroscopic characters; whereas the study of a worm from which the posterior end has been accidentally destroyed will not enable me to decide, in all cases, whether it belongs to the genus *Megascolides* or to *Notoscolex* as defined by Michaelsen.

It is not difficult to imagine the way in which the genus *Tokea* has developed from an Acanthodriline stock, in which the cylindrical prostate, instead of being coiled compactly and confined to its proper segment, has burst away from this limited position, and elongating backwards has not only become flatter but has lost somewhat of its smooth external surface. Such a form of “tongue-shaped” gland occurs in *Notiodrilus aucklandicus*, in which each prostate extends through five or six segments. From such a form *Rhododrilus* may have developed—the posterior gland has disappeared, and the sperm-duct has shifted forwards so as to open close to the anterior gland; whereas in *Tokea* the anterior gland appears to have gone, and the posterior gland to have moved forwards to meet the sperm-duct and to open externally in the 18th segment.

* In looking through the descriptions of new species of Australian worms published by Spencer (Proc. Roy. Soc. Victoria in 1892, 1895, and 1900), I find that the only species that possess elongated “tongue-shaped” prostates (he calls them “tubular,” but the figures show them to be like those of my species) extending through several segments belong to the meganephric genus *Plutellus* in Michaelsen’s sense.

The occurrence of a prostate in *Megascolides australis*, similar to that of a typical Acanthodrilid, seems to indicate that the confinement to a single segment is related to the cylindrical form; and it is admitted by Michaelsen that these "Cryptodriline" worms, belonging to the subfamily Megascolecinæ, are derived from the subfamily Acanthodrilinæ. And, on the other hand, the peculiar form of the gland in *Notiodrilus aucklandicus* illustrates the relation between a looser structure and the extension of the gland through several segments. But, although this transition of form between the "tongue-shaped" and "cylindrical" tubular prostates seems to occur, yet the flattened form appears a still later development; it occurs, for example, in the more modified genera, such as *Pheretima*.

Miss Sweet has pointed out that in the "tubular" prostate there is a lumen running the whole length of the gland; whereas in the lobate form of this organ there is, typically, no central lumen, and when it exists it is not only very small, but it has no epithelium. Unfortunately, the species examined by her do not belong to the genera under dispute, with the exception of *Megascolides illawarrae*, in which the prostate is a "somewhat long and flattened" organ, and has a structure intermediate in some respects between a truly "lobate" gland, such as exists in *Megascolex*, and a "tubular" gland, such as occurs in *Plutellus* and others; for the species referred by her to "*Megascolides*" belong to the genus *Plutellus* in Michaelsen's sense.

If I have dwelt so much on the form of the prostate, it is because it seems to me that Michaelsen has not laid sufficient stress upon this organ in shuffling the members of the "Cryptodriline series." It alone, I admit, will not serve for generic distinction; but it may possibly be useful in the formation of subgenera.

Dunedin, April 10, 1904.

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November 29, 1904.

G. A. BOULENGER, Esq., F.R.S., Vice-President, in the Chair.

Dr. Walter Kidd, F.Z.S., exhibited a drawing of the extensor surface of the hand of a Chimpanzee and made the following remarks:—

In the course of an examination of the papillary ridges in some specimens of Anthropoid Apes and Monkeys certain groups of ridges were found on the extensor surface of the terminal phalanges of the hand, apparently identical with those of the palmar and plantar surfaces. Three specimens of Chimpanzee living in the Society's Menagerie were examined, of the ages 1 year 8 months, $2\frac{1}{2}$ years, and 6 years. In the oldest of these, "Mickie," the ridges were definite and well-developed on the 2nd, 3rd, and 4th digits on both hands; in the youngest specimen, "Jack," they were absent; and in "Jimmie," $2\frac{1}{2}$ years old, they were small and ill-defined, as if in the process of development.

Direction of Ridges.

Mickie. Ridges longitudinal and reaching to the matrix of the nail on the 2nd, 3rd, and 4th digits.

Jimmie showed ridges as follows :—

Right hand	{	1st digit none.
		2nd „ oblique.
		3rd „ transverse at base of digit.
		4th „ „
		5th „ nearly longitudinal. „
Left hand	{	1st digit none.
		2nd „ oblique.
		3rd „ „
		4th „ „
		5th „ none.

In these three specimens ridges were absent from the corresponding surfaces on the feet.

The well-defined longitudinal direction of the ridges in *Mickie* is worth notice. It must be remembered in this connection that a Chimpanzee walks with the extensor surfaces of the phalanges touching the ground and the digits turned inwards, so that their long axes are at right angles to the line of progression of the animal, and accordingly the ridges of this part also occupy the same relative position. There is no correlation in this instance between the act of prehension and the direction of the ridges, though it agrees closely with the general rule which obtains in so many regions, that the ridges lie at right angles to the line of incidence of the predominating pressure on the part.

The following papers were read :—

1. Some Observations on the Field Natural History of the Lion. By Capt. RICHARD CRAWSHAY, F.Z.S.

[Received June 10, 1904.]

In offering these observations I wish it understood at the outset that I do not pose as a great lion-hunter, nor as having made lion-hunting a special pursuit, but speak merely as one who, during a period covering at intervals some seventeen years of travel and residence in Central Africa, has had many experiences with Lions.

From what I have read, and still more from the opinions I hear expressed from time to time, prevailing impressions seem so often at variance with my own observations that I have thought it worth while to record these latter.

It has always seemed to me that, though much has been written respecting the habits of the Lion in his natural state, a great portion of it is more fiction than fact: this, at least, is my experience. For one thing, the common opinion of the Lion being an animal of almost exclusively nocturnal habit—rarely or never seen in the

daytime unless roused from his lair in the gloom of some dense clump of bush or reed-bed—is quite erroneous. It is the fact that Lions are *heard* very much more at night than in daytime; nevertheless they are largely diurnal as well, though usually silent.

I have heard Lions roaring at noon on one or two occasions, and I have many times heard them as late as an hour or more after sunrise, and as early in the evening as an hour or more before sunset. The usual time is at sunset and a little after, and more especially about dawn in the early morning and thence onwards until broad daylight. I have *seen* Lions at all times of day, under all sorts of conditions, in all sorts of country, in all sorts of weather from misty rain to the hottest noonday sun of the tropics.

It is certainly not my experience that the Lion's habit is to hide himself in dark cover in the daytime—far from it. Other circumstances being equal, he likes open country and sunlight, and goes about and lies out in it freely, nothing being more to his liking than some coign of vantage commanding a view of the neighbourhood, where he can stretch himself out and survey the prospect. I have seen a Lioness and three cubs lying out on a river sand-spit in Henga in the full glare of the early afternoon tropical sun, stretched out on her belly, with her cubs crawling about her back and neck and tumbling over on to the sand. On another occasion about 10 A.M., also in Henga, I saw a Lioness sitting up on her haunches on a flat-topped ant-hill, watching and listening to my men talking and laughing as they were skinning an Impala shot half an hour previously.

The same instant as I made her out and levelled my glasses on her at a distance of some 300 yards, she slunk down behind the ant-hill—melting away, as it were, in the endeavour to make her movement as unnoticeable as possible.

I have seen a Lioness crossing the bare scorching lava-covered plain intervening between the East-Africa and Uganda Protectorates in the fierce heat of noon at midsummer, with the heat radiating in lambent tongues from the ground, giving her the appearance of being enveloped in fire.

Nothing had disturbed her, as this country was uninhabited by man; she was making her way to the water.

On another occasion I saw three half-grown cubs near the same spot in the early afternoon, in the hottest sunlight, playing about in the open on the banks of the stream.

Once, in Henga, I came across a troupe of five Lions on the move at noonday. It had been raining about an hour before, but the sun was then out in all its power of midsummer, as they crossed from open country to go into the scrub on the banks of the Lunyina River.

In Henga, in 1893, about an hour after sunrise in the hottest time in all the year, a full-grown dark-maned Lion passed down the valley below me following a game-track at a long striding walk, throwing up his head and roaring at intervals as he went,

making daytime hideous and stampeding the game in ridiculous fashion. Hartebeestes were sneezing, Reedbuck whistling, and herds of Zebra thundering about all over the place. I was actually stalking him at an angle to cut him off, when the late Surgeon McKay fired at another Lion a few hundred yards lower down the river, killing his first Lion and spoiling my chance.

In 1893 I had a curious experience with a Lion—also in Henga,—which, for aught I know, may have occurred to me oftener without my having been made aware of it. In stalking two old bull Hartebeestes up a slope in country timbered sparsely with sapling trees and bushes, I passed within some 20 paces of a Lion lying on the bare burned ground in the shade of a sapling without knowing it at the time. On my return from shooting both Hartebeestes, one of my men followed me and told me, pointing out the Lion lying under the tree.

On setting out to stalk the Hartebeestes, I left my two gun-bearers sitting on the steep slope on the other side of the stream, and myself descended to cross the stream and stalk my way up the opposite slope within easy view of the men. What first drew their attention to the Lion was his moving his head as I passed him all intent on my stalk, looking neither to my right nor left.

According to my men, I passed within 20 paces of him, to windward, nothing whatever intervening between us but the bare fire-swept ground. He did not catch my eye as he lay in a black patch of shadow—so black that when the man afterwards pointed him out to me from above and not in relief, I could not make him out. As I passed, he lay placidly where he was, merely raising and lowering his head—like a dog winding game—as he winded me. Had my eye happened to catch his, he would have behaved otherwise, no doubt; he would either have made a demonstration to put me to flight, or have retreated under protest, grunting, as Lions usually do.

Another popular idea of the Lion is that he becomes a man-eater only in extreme old age from force of circumstances. I do not agree with this at all. I believe rather that he learns this in the first instance more often under the impulse of hunger or passing caprice than of failing strength, and having thus overcome the natural repugnance and instinctive fear which all the lower animals have for man, finds in him an easy victim and henceforth constitutes him his special prey.

In evolving this habit Lions also evolve *extraordinary* cunning not primarily their own. In man they recognise a creature of higher intelligence than theirs, and pit themselves to meet this. What they seem to become aware of is that, if they are to overcome man, they must take him at a complete disadvantage—that unless they do so he is their master against whom mere force as applied to other creatures will not prevail.

From contact with man they become extraordinarily conversant with his habits, using this knowledge against him. Nevertheless, though they become extraordinarily cunning in plans of attack,

they also become abnormally cowardly should such plans fail. I have known remarkable instances of this.

Another point on which I cannot endorse the general theory is that of the Lion being a fastidious feeder, eating almost exclusively his own kills, his prey being the larger mammals—buffalo, zebra, and antelope. I have not found this to be so as regards his being a fastidious feeder. In my experience Lions feed freely on carrion—often far gone in putrefaction. Sometimes also they prey on such very small game as the smaller rodents.

Mr. Selous has it on record how on one occasion a Lion ate the skin of a Sable Antelope treated with arsenical soap for preservation as a natural-history specimen. Nothing so remarkable as this has occurred within my personal knowledge. It is probably an almost isolated case. As an instance of the Lion's primary fear of man and also of his eating carrion, I remember a case to illustrate this which occurred to me on the western shores of Lake Nyasa in 1885. I had shot two Elephants in the afternoon, and after following up the herd with no further results than to have to shoot a calf practically in self-defence, I returned some time after dusk to where I had killed my first Elephant, and there slept under the belly and between the legs of the animal to be in readiness to cut out the tusks in the morning. In those days, in that country, Lions gave little anxiety on the score of being man-eaters; therefore no precautions were taken to guard against them, either in keeping watch or burning large fires. Had I had some of my experiences of later years I could never have slept as I did then—lying down anywhere and never keeping a watch or burning a fire except to cook. Nothing occurred during this particular night to disturb my rest. It was a surprise, however, when morning light came, to find on the loose soft ashes of the grass burned the day before that a troop of Lions had circled round, desirous of feeding on the carcase, but deterred by the presence of man.

The following night, after the tusks had been cut out and I had moved camp to a point about a mile away, they returned and fed on what remained of the flesh, then putrid from exposure to the sun.

On the Lower Shiri Plains, British Central Africa, in 1885, I shot a very fine Lion whose stomach was full of Elephant's trunk—an Elephant killed by natives and cut up by them, the knife-cuts in the flesh and hide being at once noticeable. He had made a huge and rapid meal—chunks of solid flesh, with pieces of the hide attached, weighing several lbs. each, had been bolted whole. He was a very fine Lion, in splendid condition and in the prime of life, as could be seen from the skull.

As regards Lions preying on other game than large mammals, I have already mentioned to this Society (P. Z. S. 1904, vol. ii. p. 144) an interesting case of a Lion which I believe to have preyed on porcupines.

In 'Mammals, Living and Extinct,' Sir William Flower remarked that probably Lions paired for life: this is so, I think.

What induces me to this belief is the inconsolable behaviour of the remaining one of a pair should the other be killed, no matter whether the survivor be the male or female. It is really touching. I shall never forget the moaning sobs of the mate of the Lion killed N.W. of Kibwezi during the entire succeeding night, nor the continuous melancholy roaring of the mate of the Lioness killed in Henga in December 1893.

2. On some Nudibranchs from East Africa and Zanzibar.
Part VI. By Sir C. ELIOT, K.C.M.G., late H.M. Commissioner for the East African Protectorate, F.Z.S.

[Received October 6, 1904.]

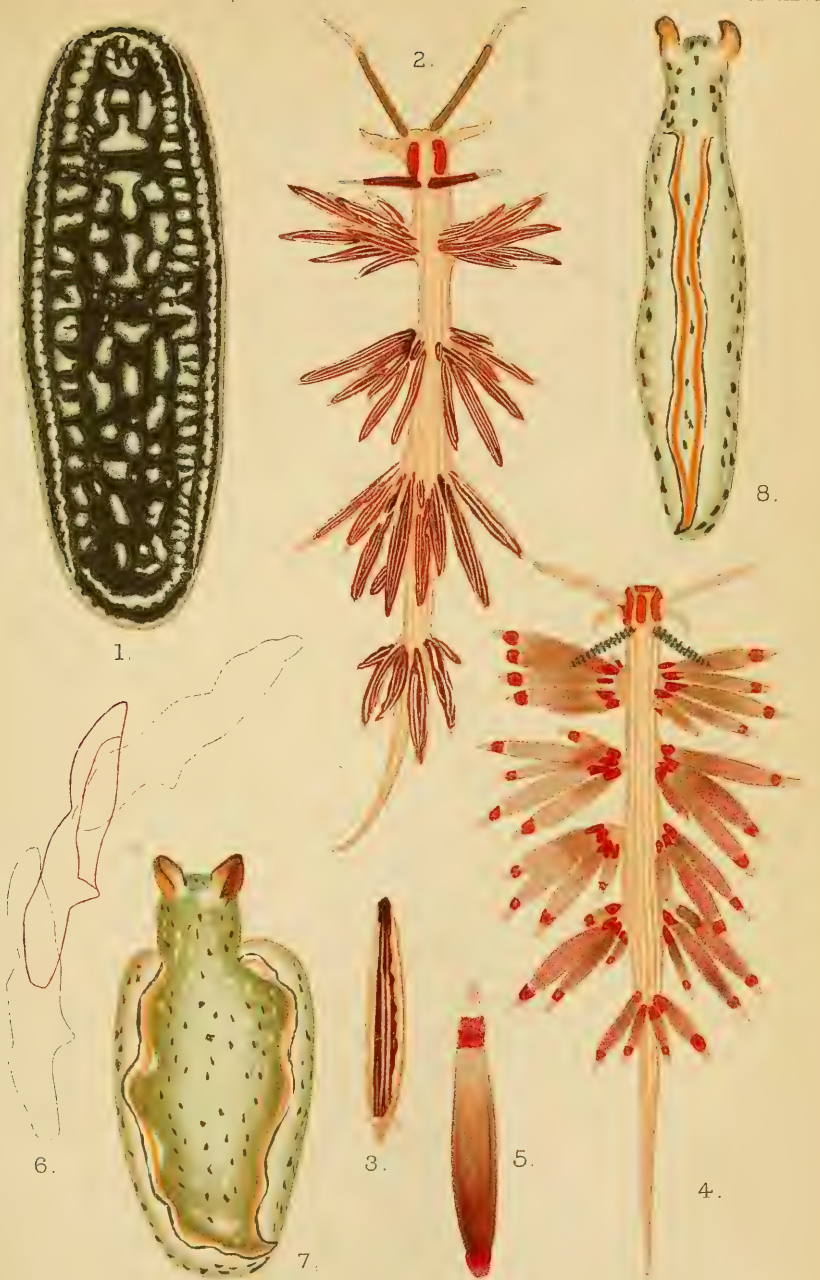
(Plates XVI. & XVII.*)

This paper contains an account of the following Nudibranchs collected in Zanzibar or East Africa:—

1. *Orodoris striata*, sp. n.
2. *Hexabranchus lacer* Cuv., varieties *faustus*, *marginatus*, and *moebii*.
3. *Doridopsis tuberculosa* (Q. & G.).
4. *D. spiculata* Bgh.
5. *D. pudibunda* Bgh.
6. *D. nigra* (Stimpson).
7. *D. denisoni* (Angas).
8. *D. clavulata* A. & H.
9. *D. rubra* (Kelaart).
10. *Phyllidia varicosa* Lamarek.
11. *Ph. nobilis* Bgh.
12. „ „ var. *rotunda*, nov.
13. *Ph. pustulosa* (Cuv.).
14. *Phyllidiopsis cardinalis* Bgh.
15. *Doto africana*, sp. n.
16. *Fiona*? *pinnata* (Eschsch.).
17. *Hervia lineata*, sp. n.
18. *Phidiana tenuis*, sp. n.
19. *Facelina lineata*, sp. n.
20. *Phyllodesmium hyalinum* Ehr.
21. *Stiliger varians*, sp. n.
22. *St. irregularis*, sp. n.
23. *Phyllobranchus prasinus* Bgh.
24. *Cyerce elegans* Bgh.
25. *Placobranchus ocellatus* Van Hass.
26. *Elysia faustula* Bgh.
27. *E. marginata* Pse.
28. *E. dubia*, sp. n.

It is very likely that some of the smaller forms are immature,

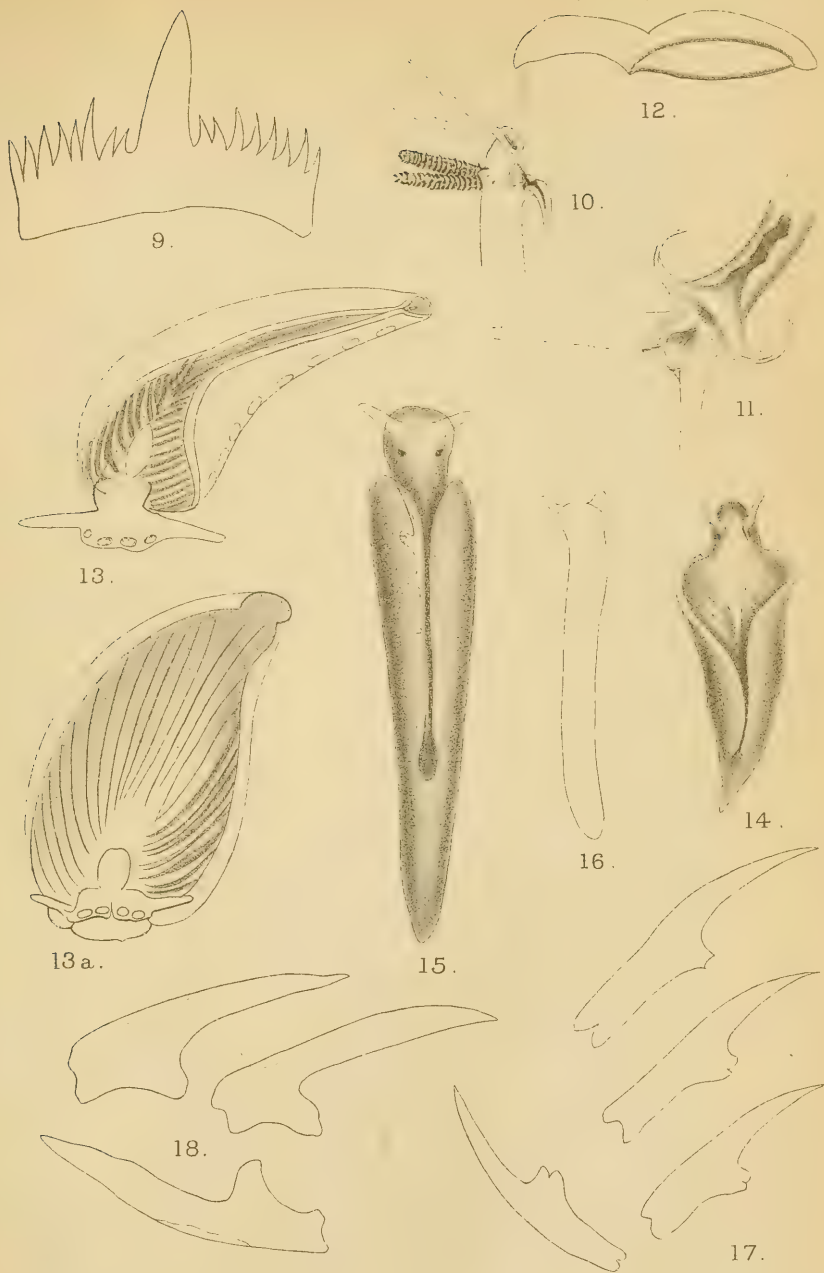
* For explanation of the Plates, see p. 297.



C. Crossland, del.

Huth, sc. et imp.

1. PHYLLIDIA NOBILIS. 2. 3. HERVIA LINEATA.
4. 5. FACELINA LINEATA. 6. STILIGER VARIANS.
7. 8. ELYSIA MARGINATA.



C. Crossland, del.

Huth, sc. et imp.

9. MADRELLA FERRUGINOSA. 10. 11. FACELINA LINEATA
12. STILIGER IRREGULARIS. 13. 13a. PLACOBANCHUS
OCELLATUS. 14-17. ELYSIA DUBIA. 18. E. MARGINATA.



but if they are noticed at all it seems simpler to give them a specific name.

MADRELLA FERRUGINOSA.

In the plates of *Madrella ferruginosa* in the first of these papers (P. Z. S. 1902, vol. ii. pl. vi. fig. 6) the central cusp of the median tooth is represented as much too blunt, and I now give a new figure of it (*cf.* Pl. XVII. fig. 9). It is really long and rather pointed. This character is quite clear in the hinder part of the radula, but in the front part it would appear that the end of the central cusp becomes broken or worn off and the point looks blunt as in the first figure above referred to.

ORODORIS.

[Bergh, Jour. d. Mus. Godeffroy, Heft viii. 1875, pp. 67-71.]

ORODORIS STRIATA, sp. n.

One specimen from Pemba found on the shore crawling among *Ulva*. The description of the living animal is as follows:—"Six inches long. The ground-colour of the back is greenish centrally and deep green and chocolate laterally. The mantle-edge has a wide border half an inch wide. The most characteristic external feature is the presence of numerous prominent, narrow ridges running over the back. The back also bears fairly large tubercles over which these ridges continue. There are three circular areas on each side of a deep green colour where the ridges are absent. The ridges are usually white, but in places are tinged with greenish grey. The rhinophores are vertical, the pockets a little raised at the edges. The gills are 8, fairly large, having a fluffy appearance, but not very sensitive. The anal papilla and main rhachis of the gills are pink. The secondary branches are light brown and the smaller branches white. The gill-pocket is irregularly lobed. The mantle-edge is soft but stiff in texture, and may assume a very wavy outline. The under side of the animal is white, with a narrow, irregular, brownish line near the junction of the mantle and the foot."

The preserved specimen has suffered severely from contraction, and most of the internal organs except the buccal mass have been lost through a rent in the side. The actual length and breadth are 71 and 59 mm., but could be increased by at least a centimetre each if the animal were straightened out. The unusually strong and fleshy mantle-edge is 9 mm. thick. The colour is a uniform yellowish white. The characteristic curved ridges are still plainly visible, but the tubercles are somewhat obscured; there seem to be four between the rhinophores and branchiæ and one behind the branchiæ; two can be distinguished on each side. The pockets of the rhinophores are 4 mm. high. The gill-pocket is raised and bears 8 irregular lobes. The 8 branchiæ are strong, with broad stems, and mostly quadripinnate. The anal papilla is large, crenulate, and connected with one of the anterior gills by a

lamina. The foot is strongly grooved in front, but not notched. On each side of the mouth is a large but not very distinctly shaped lump, which seems to represent a retractile and furrowed tentacle.

The labial armature consists of a dense mass of light yellow bent rods, not bifid, exactly like those in Bergh's plates of *O. miamirana*. The radula is large, broad and tough, yellow behind, dark brown in front; it consists of 120 rows, the widest of which have at least 130 teeth on each side of the rhachis. No rhachidian thickenings are visible, but otherwise the radula closely resembles that of *O. miamirana*. The first teeth bear two strong denticles on each side of the central cusp; the next 10-15 are denticulate on the outer side only, bearing as many as 10 denticles. The remainder are simply hamate. The outermost are smaller and rather irregular, but not denticulate.

The specimen is clearly an *Orodoris* and closely allied to *O. miamirana*, particularly the specimen described by Bergh (*l. c.* p. 71) as coming from Zamboanga. It is, however, superficially extremely unlike the preserved specimen of *O. miamirana* given me by Dr. Willey, and I hesitate to regard it as a mere variety. The main difference is that whereas in *O. miamirana* there are ridges on the back formed by compound tubercles, there are in this form a large number of narrow longitudinal as well as transverse ridges which pass over the tubercles as well as the general surface of the back.

HEXABRANCHUS Ehr.

[See (1) Bergh, S. R. Hefte xiii., xvi., and Supplem.-Heft i. (2) Eliot in Gardiner's Fauna and Geog. of Maldiva and Laccadive Archipelagoes, vol. ii. part 1 (1903). (3) Bergh in Schauinsland's 'Reise nach dem Pacific: Die Opisthobranchier.']

The Hexabranchidæ, which are very common in the Indo-Pacific, but not recorded from other seas, are large doridiform animals of brilliant coloration and active movements. They differ from the cryptobranchiate Dorids chiefly in having no branchial pocket but a circle of separate branchial tufts, each of which contracts when touched into a temporary hollow which forms at its base. The texture is soft and smooth, the shape flattish, the mantle-margin ample, and the tentacles foliaceous. There is a strong labial armature, and the radula is similar to that of many Dorids, consisting of simply hamate teeth with the formula $\infty.0.\infty$. The verge is extremely long and the nervous system much concentrated.

Bergh observes (*l. c.* (3) p. 225): "Eine Reihe von etwa 20 Arten ist angegeben welche zum allergrössten Theil doch wohl nur Varietäten oder Localformen einer sehr verbreiteten längst erwähnten Art sind, des *Hex. lacer* Cuv."* My own observations support this, as far as the three forms here mentioned are

* It seems to me quite clear that Cuvier's *Doris lacera* is a *Hexabranchus*, not a *Doridopsis*.

concerned. The shape and colour of the living animals are both very variable. The former can be altered at will from an almost circular to a long slug-like shape, in assuming which latter the mantle-edges are folded over the back. The colour varies even in the same animal, and individuals kept in captivity become conspicuously paler and duller in a few hours. As is usually the case with soft Nudibranchs, the preserved specimens are much subject to distortion in alcohol, and such characters as the expanded or contracted state of the branchiæ and the flat or arched shape of the back appear to have no specific importance. I think that *H. digitatus* described by me (*l. c.*) is a distinct form, but its state of preservation is such that it is difficult to say whether it should be referred to *Hexabranchus* or to a new allied genus. None of the other specimens which I have examined show any material differences in structure or anatomy. The active habits of the animals perhaps explain how it is that one varying form is spread over so large an area.

The numerous specimens which I have collected in Zanzibar and on the East Coast of Africa represent three varieties:—

(1) *H. faustus* B.—This form, which is not very abundant, seems characterised by its prevailing red coloration and the absence of any white bands. One specimen was of a dark blood-red all over, with only a few yellowish markings at the sides of the visceral mass, but in most cases this dark blood-red is confined to a fairly broad irregular border. The centre of the back is of a lighter red, with mottlings of various tints of red and orange. Between this region and the border the colour is of a dull reddish grey. The specimens obtained of this variety are of moderate size, not exceeding 8 centimetres in length.

(2) *H. marginatus* (Quoy & Gaimard).—This variety, which is also not very common or very large, is characterised by having a broad red band round the mantle, divided in the middle by a white line. In addition to this there is sometimes, but not always, a white edge to the mantle. The middle of the back is mottled red and orange.

(3) The third variety, which is also the commonest, is the animal captured by Moebius at Mauritius, and described by Bergh (*S. R.* xvi. p. 828 ff.) as *H. marginatus* (Q. & G.). Though it is probably not specifically separate from *H. marginatus*, Bergh seems to have overlooked the fact that it constitutes a variety quite as distinct as the other so-called species. Its chief characteristic is clearly given by Moebius:—"Die obere Seite des Mantelgebrämes nach innen porzellan weiss, nach aussen mit breitem rothem Saume von welchem abwechselnd kleinere und grössere Bogen nach innen laufen." Though the difference between this form and *H. faustus* is really only one of degree, the brilliant white band between the equally brilliant deep red border and the variegated central region is most conspicuous, and the animal looks superficially quite distinct from those described above. I propose to call it var. *moebii*.

This variety is very common and grows to a very large size,

one specimen being as much as 25 centimetres long and 16·5 broad. It is very active, swims rapidly, and has been found on the surface of the sea a quarter or half a mile from the shore. The colour of the dorsal surface within the borders is very varying and may be bright light-red, orange, yellow, sandy, almost white, or still more frequently mottled with all these colours. Sometimes the external red border is divided into two parts by a lighter line as in the last variety. The branchiæ exhibit somewhat similar variations of colour, but are generally of a pale reddish yellow with darker lines on the axes and white tips to the pinnae. Sometimes the main axes are bright light green.

I have been unable to find any differences of structure between these three varieties: *faustus*, *marginatus*, and *moebii*. In all the radula consists of from 30–45 rows of simply hamate teeth, rather slender, 65–80 on each side of the naked rhachis. The branchiæ are from six to eight, seven being perhaps the commonest number. Each so-called branchia consists, as a rule, of four plumes (but sometimes of three or five) inserted very close together but not springing from a common stem. Not unfrequently one plume is separated a little from the others, and the individual then appears to have an abnormally large number of branchiæ.

DORIDOPSIS.

This genus is distinguished from the other cryptobranchiate Dorids by having a suctorial buccal apparatus, with no jaws or radula. The mouth is a fine pore situated in the anterior part of the foot; and the internal organs consist of a buccal cone from which issues a long tube which is generally twisted and expands into a dilatation before entering the liver. Beneath the anterior part of the tube is a large folliculate mouth-gland, generally double. The true salivary glands appear to be represented by two nodules at the commencement of the dilatation. The nervous system is very concentrated. The liver is bifid behind. There is an armature of minute hooks on the spermatic duct and glans. On the upper wall of the pericardium are a number of lamellæ, sometimes called the pericardial gill. The animals are generally soft, more rarely spiculous, either smooth or tuberculate. The branchiæ are rather large and few (rarely more than 8), and though they are completely retractile, are very commonly exerted in preserved specimens so as to appear at first sight non-retractile. This feature seems to depend on some peculiarity of texture, and not on any difference of structure.

The genus is very abundant in the Indo-Pacific, and about 60 species have been described, many of doubtful validity. Even in dealing with the forms which are adequately described, it is not easy to draw the line between species and varieties, as nearly all are very variable both in shape and colour, and the internal organs present few features which can be safely used for classi-

fiction. It is noticeable that none of the species here mentioned are new, although in other genera novelties have been abundant on these coasts.

DORIDOPSIS TUBERCULOSA.

[Bergh, Jour. Mus. Godeffroy, Heft xiv. 1878, pp. 38-40, and n S. R. xvi. 2, pp. 845-848.]

Several specimens from the East and West Coasts of Zanzibar.

The following are the notes on one of the living animals:—"Gill-pocket shaped like that of *Asteronotus*, 5-lipped. Gills five, quadripinnate, large, and brown. Rhinophores bent backwards, pockets raised at edges. Body soft but firm; grey with black patches; back covered with large compound tubercles. Under side of mantle and sides of foot a dirty brown with white blotches; foot lighter and without blotches. Free mantle-margin about 20 mm. A most handsome creature."

The dimensions of the largest alcoholic specimens are, length 97·5, breadth 60·5, height 36 mm. The free mantle-edge is ample and the foot of moderate size (58 mm. long by 25 broad). The colour is much as described in the living animals, but in two of the specimens the tubercles are plentifully besprinkled with black dots. The whole back is covered with compound tubercles, which are smaller towards the mantle-edge. The rims of the rhinophore-pockets are prominent but not conspicuous; the club of the rhinophores is set at almost right-angles to the thick stalk and bears 50-60 deep perfoliations. The branchial aperture is raised and stellate; it can be almost closed by five triangular lobes which bear tubercles on the outside. The five branchiæ are quadripinnate with remarkably stout stems. In one specimen there are six lobes and six branchiæ. The anterior part of the foot is much retracted and distorted in all the specimens, but it appears to be thickened and notched but not grooved.

The buccal cone is 5·5 mm. long in the largest specimen. From it issues a long narrow tube (36 mm. by 2 mm.), bent almost into the shape S on the left side, with a smooth interior, which then dilates more or less clearly in different specimens into a sausage-like shape, 25 mm. long by 10 broad. The walls of this dilatation are strong and laminated internally. After it the digestive tract narrows again, and a tube 9 mm. long and 5 broad leads into the hollow of the liver. This organ is very large (51 mm. long by 38 broad), yellow, and distinctly bilobed behind. The mouth-gland is large, yellow, and with several lobes. The salivary glands are small, oval, and set at the top of the sausage-shaped dilatation. The single blood-gland is elongate and purple. The central nervous system is as usual in the genus. The pericardial laminæ are distinct and yellowish. The albumen and mucous glands are very large: the vas deferens is thin, extremely long, and much convoluted. The verge is armed with numerous colourless spines, not much bent, rather irregular in shape and rising out of circular discs.

DORIDOPSIS SPICULATA, B.

[See Bergh, Jour. Mus. Godeff. Heft xiv. p. 37.]

One specimen from Wasin. The notes describe the living animal as three-quarters of an inch long, high and narrow in shape. The back was covered with numerous small, flat-topped warts and was visibly full of spicules, particularly at the bases of these warts. The colour was white, except for a row of small dark grey spots of irregular shape on each side of the visceral mass and a few other scattered spots. The foot was broad.

The preserved specimen is of a uniform greyish white; the skin is hard and full of spicules. The length is 9 mm., the breadth 4, and the height 2.5. The mantle-edge is narrow. The back is covered with flat warts, bearing smaller tubercles, and there are also a few simple papillæ. The branchial opening is not much raised and slightly crenulate. The branchiæ are six, tri-pinnate, and set in an incomplete circle which is open behind. The foot is pointed at both ends, with uncertain traces of a notch and groove in front. The tentacles are small.

The internal organs are mostly yellowish and present nothing remarkable. The pericardial lamellæ and penial hooks are present as usual in the genus.

This specimen has the main characters of Bergh's *D. spiculata* from the Philippines. The difference in form is not remarkable, as the animals of this genus frequently alter their shape from long and high to flat and broad, but the discrepancy in the number and arrangement of the branchiæ throws some doubt on the identification. Bergh's specimen had only four.

DORIDOPSIS PUDIBUNDA, B. ?

[Bergh in S. R. xvi. 2, pp. 844-5. Cf. id. Jour. des Mus. Godeffroy, Heft xiv. 1878, pp. 33-4.]

Four specimens from Chuaka. The ground-colour of the living animals was whitish, but almost hidden by two sets of blotches, one of which varied from light reddish brown to deep dark brown, and the other from pale blue to an inky colour. The intensity of coloration varied in different specimens, and was also greater in the middle of the back than on the mantle-edges. The mantle-edge changed considerably in shape and size with the movements of the animal. The branchiæ were lined with dark brown and not very sensitive; the rhinophores dark brown and tipped with white.

The preserved specimens are stout and high in shape, and have retained their colour fairly well. The largest is 30 mm. long, 17 high, and 22 broad. The mantle-edge is crinkled and allows the sides of the foot to be seen. In one specimen it is much wider than in the others, and this specimen is flatter than the others. The back is smooth, arched, and appears to be swollen. The pockets of the rhinophores and branchiæ are slightly raised and smooth. The rhinophores are somewhat bent backwards and bear about

25 perfoliations. The branchiæ are six in number, quadripinnate, low but strong and bushy. The circuit is open behind, and the subcentral anal papilla very large. The foot is notched in front, but not grooved; the tentacles are small and adherent. The integuments of the body are thick and tough.

From the small reddish buccal cone issues a long thin tube, which is twisted into a shape somewhat like **S** on the right-hand side. The mouth-gland is bilobed. The pericardial lamellæ are yellowish and not very distinct. Bergh says, "Im Penis wurde eine Haken-Bewaffnung nicht nachgewiesen"; and I could find none in two specimens. In the third there were clearly visible about 12 rather irregular rows of thick-set, transparent, hooked spines.

These specimens seem referable to the forms described by Bergh in the passages referred to, though the descriptions are not altogether clear. In the specimens from the Philippine Islands the back was "aufgedunsen knotig"; in that from Mauritius, "die Form-Verhältnissen die gewöhnlichen."

DORIDOPSIS NIGRA (Stimpson) A. & H.

[A. & H., Coll. of Nudibr. Molluscs made in India, p. 128; Bergh, S. R. xvi. p. 842, xvii. p. 963; id. Danish Exped. to Siam, p. 191; id. Beitr. zur Kennt. Japan. Nudibr. p. 181.]

Forms which seem referable to this species are among the commonest Nudibranchs on the coasts of both Zanzibar and the mainland. The species, as well known, is extremely variable not only in its colour, but also in its shape, in the number and form of the branchiæ, the presence or absence of tubercles, and the configuration of the anterior foot and tentacles, though with regard to the last point it must be remembered that this is the part of the body which is most liable to be obscured and distorted by alcohol. The internal structure of all the varieties seems much the same, and does not present any very remarkable features. The organs are mostly yellowish. The tube which issues from the buccal cone is at first narrow (generally about 1 mm.) and bent considerably, usually on the left-hand side; it then dilates into a sausage-shaped expansion of about double the width, after which it enters the liver. The mouth-gland is distinct and bilobed. The pericardial lamellæ are well developed. The verge is armed with spines of irregular shape.

The chief varieties are as follows (the texture is in all cases very soft):—

(1) Jet-black, without any spots or markings, but white tips to the rhinophores. This form does not appear to be common; I have only two specimens from Mombasa and two from Zanzibar. The animals are not very large (about 20 mm. long and 10 broad) and flattish. The branchiæ are six. In three specimens the anterior margin of the foot appears to be entire and the tentacles are very indistinct. In the fourth both the tentacles and the groove are clear.

(2) Jet-black, with a brick-red band running round the body,

but wider anteriorly than posteriorly and visible from the under side of the mantle. Rhinophores black with white tips. Foot broad, grey. Branchiæ six. Only one specimen.

(3) Brownish, with a red line much as in the last variety, but occasionally broken and accompanied by red spots at the sides. In the centre of the back are some clusters of whitish spots, and there is a red band round the foot. The genital papilla is yellow and conspicuous. Branchiæ six. The foot is narrow, pointed at both ends, and grooved anteriorly. No tentacles are visible. Only one specimen. Length 24.5 mm., breadth 8.5, height 5.

(4) The commonest variety of all is of a greenish black, of varying intensity, with white spots. A. & H.'s figure No. 13 gives a good idea of an average specimen. The animals are about 30 mm. long and 10 broad, and somewhat globular, though, like most Doridopsids, they can alter their shape. The branchiæ vary from 6 to 12 in number and are usually ample and fluffy. As a rule, the foot is plainly grooved, and the small flattish tentacles are distinct. In coloration there are many subvarieties. Generally there are both clusters of small white spots and scattered larger white spots. In the specimens where the pattern is most developed the clusters are arranged in two symmetrical lines down the back, and the scattered spots are more numerous round the margin, where they tend to form a border. Irregular black blotches may be present or absent. But in some specimens the markings are much reduced, and in one there is only a single white spot.

(5) A variety with raised tubercular spots is fairly common. The specimen which shows this feature best is flat and elongate. Down the centre of the back is an elaborate pattern consisting of clusters of white spots in two rows and scattered white spots between them, and round the mantle-margin is a ring of elongate white spots forming an interrupted border. The spots, especially those near the edge of the mantle, are distinctly raised and tubercular. The branchiæ are fully exposed, 10 in number, and somewhat stiff and meagre. The anterior margin of the foot is grooved and the tentacles are distinct. If this specimen were isolated, I should certainly regard it as specifically distinct, but a number of intermediate forms seem to show that it passes imperceptibly into variety 4, as regards both the tubercular spots and the branchiæ.

(6) I have once found a specimen of a uniform greyish white, with no markings and six branchiæ.

I am indebted to Mr. F. W. Townsend, of the Indo-European Telegraph Service, for two specimens from Karachi, which may be referable to this species. According to his notes and a rough pencil-sketch, the animal was much broader behind than before, of a very deep purple, with a bright crimson line round the undulated mantle-edge. The branchiæ were the same colour as the body and fern-like.

The two preserved specimens retain the coloration fairly well

and are hard and stiff. The largest is 26 mm. long and 12 high, 7 broad as measured across the rhinophores, and 15 across the branchiæ. The integuments are thick and tough, the intestines bright yellow, and as usual in the genus. The branchiæ 8; the anal papilla not in the centre but somewhat to the right.

These specimens do not look like *D. nigra* as preserved, and apparently did not look like it when alive, since they were kept separate from normal examples of the species, but it is difficult to formulate any distinguishing characteristics except the stiffness and thickness of the integuments.

DORIDOPSIS DENISONI (Angas).

D. gemmacea A. & H.

[Angas, Descr. d'espèces nouvelles de Moll. Nudibr., Journal de Conchyl. sér. 3, iv. i. 1864, p. 45; A. & H., Coll. of Nud. Moll. made in India, p. 126; Bergh, S. R. xv. p. 694 ff.]

One small specimen from near Wasin, East Africa.

The living animal was long, narrow, and high; the mantle-edge, though not wide, descended straight down to the ground on each side, so that the sides of the foot were hidden by it. The central part of the back was flat and smooth, but bounded on each side by three large tubercles. Two more stand in the median dorsal line immediately before and behind the rhinophores. A few more tubercles are scattered here and there near the sides. In the centre of the back were two large eye-like spots (similar to those found in some species of *Notarchus*), bright blue with rims of dull dark yellow, and on each side were five double spots (each like the figure 8) of similar colour. The tubercles were tipped with brown, underneath which was a band of yellowish white. The ground-colour of the back and of the bases of the tubercles was reddish brown with clear lines of yellowish white. On the mantle was a border formed by alternate blotches of pale yellow and light crimson. The under surface was of a beautiful pink, deeper towards the mantle-edge, but without markings. The edge of the gill-pocket was slightly toothed. The gills 5, tripinnate, but not ample, white, with dark brown lines on the rhachis. The animal was flexible and lively in its movements; the tops of the tubercles were often drawn in and then thrust out again. The beating of the heart was distinctly visible under the skin.

The preserved specimen is 7 mm. long, 3 broad, and 2.5 high. The mantle-edge is narrow. The lumps on the back remain fairly distinct. The rhinophores are large, the tentacles small. The five gills are erect and strong, but not very ample. The internal organs are yellowish, and seemed to be as usual in the genus. Pericardial lamellæ were not discovered, but this was probably due to the small size of the specimen.

Angas's *D. denisoni* is identified with A. & H.'s *D. gemmacea* by Bergh, in spite of considerable differences of colour, and *D. gemmacea* is said to vary a little in colour and markings. The present specimen is clearly allied to these forms, and as, in view

of its small size, it is probably immature, the difference in pattern is perhaps not specific. The chief distinction is that here we have yellow ocelli with a blue centre, whereas in A. & H.'s specimens there were "lozenge-shaped areas of a rich brown colour, with a few brilliant blue spots in each."

DORIDOPSIS CLAVULATA.

[A. & H., Notice of a Coll. of Nudibr. Molluscs made in India, p. 127.]

One specimen dredged between Wasin and the mainland in 10 fathoms.

The following are the notes on the living animal:—"Very like *D. denisoni*. Probably a distinct species, but nearly related. Shape as *D. denisoni*, but even longer. The tubercles are not so large or so definite, and the back is rounded. There are two small tubercles between the gills and rhinophores, and the rest of the back is fairly thickly covered with smooth warts. The mantle has a border formed by blotches of greenish black, white, and yellowish brown. The whitish patches extend inwards, and there are three others in the middle of the back. On each side are three smooth irregular patches of yellowish brown, with scattered slit-like marks of bright blue. Apart from these various markings, the ground-colour is a dull red. The tops of the tubercles are greyish, but this does not altogether hide the underlying red or white. The edges of the rhinophore and gill-pockets are slightly raised, and the latter is wavy. Gills 5, large, feathery, tripinnate, white, with black lines on the rhachis. Rhinophores dark brown, tipped with white, not bent back. Anal papilla large, and keeps up a motion like the beating of a heart. Foot pinkish, with a yellow border, only slightly projecting behind mantle. The animal is infested with numerous white copepoda, especially about the gills."

The alcoholic specimen is very soft and much bent. It would probably be at least 25 mm. long if straightened out; width 13 mm., height 12. The mantle not ample but reaching to the ground. The rhinophore-pockets bear one or two tubercles. The gill-pocket is indistinctly five-lipped and also irregularly denticulate. There are indications of three or four large tubercles on each side of the back twice as large as the rest, although the description of the living animal does not notice them. The foot is deeply notched in front, but not distinctly grooved. The tentacles are thin but distinct. The internal organs are yellow and as usual in the genus. The mouth-gland falls into two halves, each with several lobes.

I think that this may be identified with A. & H.'s *D. clavulata*, which may perhaps be shown by the discovery of intermediate forms to be the same as *D. denisoni*. *D. nicobarica* B. appears to be akin.

DORIDOPSIS RUBRA (Kelaart) A. & H.

[A. & H., Notice of a Coll. of Nudib. Moll. made in India, p. 126; Bergh, Danish Exped. to Siam, Opisthobranchs, pp. 190-1.]

This form is common both in Zanzibar and on the mainland. The notes on the living animal describe it as a "Large bright red *Doridopsis*, between crimson-lake and vermilion: the back above the viscera blotched with small irregular spots of chocolate-brown. Length two and a half inches, breadth at most two inches; texture of skin smooth and shiny; body very contractile. Gills 6; feathery, tripinnate. Gills and rhinophores rapidly and completely retractile."

Six specimens are preserved, all much contracted and blistered. Two are uniformly white; in the rest the dark mottlings remain. The skin is soft and smooth; the mantle-edge fairly ample; the foot fairly wide and slightly pointed both before and behind. The rhinophores are set very far in front and the branchiæ very far behind. The pockets of both have slightly raised smooth margins. The branchiæ are tripinnate, generally exposed, fairly luxuriant, and apparently six in all specimens. No head or tentacles are visible in any of the specimens, but while in the two white ones the anterior margin of the foot appears to be simple, it is distinctly grooved in the others.

The internal organs are mostly of a reddish yellow and arranged as usual in the genus. The mouth-gland is bilobed. From the buccal cone issues a long thin tube about 1 mm. broad, which is generally curved into the shape of S, and then dilates into a wider portion, about 2 mm. broad, which is constricted before it enters the liver. The mouth-gland is bilobed, the eyes large and distinct. The verge and part of the seminal duct are armed with small hooks of a rather irregular shape.

The difference of colour in the preserved specimens, coinciding as it does with a somewhat different shape of the anterior pedal margin, suggests that the specimens may really belong to two species, although the notes do not indicate any difference in the appearance of the living animals. Possibly *D. rubra* and *D. brockii*, as Bergh suggests, are merely varieties of a very variable form.

PHYLLIDIADÆ.

[See Bergh, "Bidr. til en Monogr. af Phyllidierne," Naturh. Tidssk. 3 R. v. 1869; id. Neue Beitr. zur Kenntniss d. Phyllidiaden, 1876; id. in S. R. xvi., xvii. Eliot, Nudibranchiata in Gardiner's Fauna of Maldives and Laccadives, p. 560 ff.]

The structure of these well-known and unmistakable animals has been so thoroughly examined by Bergh that it need not be described here. Five genera have been proposed: *Phyllidia* (Cuv.) B., *Phyllidiella* B., *Fryeria* Gray, *Phyllidiopsis* B., and *Ceratophyllidia* Eliot. The last three genera have all decided characters. In *Fryeria* the vent is terminal and not dorsal; in

Phyllidiopsis and *Ceratophyllidia* the mouth-parts are much as in *Doridopsis*, the glands not being fused with the buccal tube, and *Ceratophyllidia* has the additional peculiarity of bearing stalked globes on the back. The distinction between *Phyllidia* and *Phyllidiella* seems to me less certain. According to Bergh, (a) the oral tube is symmetrical in *Phyllidia*, asymmetrical in *Phyllidiella*; but I have not found the difference to be clear or persistent, and even if it is so, I doubt if it is of generic worth. (b) In *Phyllidia*, "Dorsum tuberculis elongatis, plus minusve confluentibus obsitum, medio varicositates longitudinales formantibus." In *Phyllidiella*, "Dorsum proprium tuberculis discretis vel pro parte confluentibus quincunces formantibus obsitum." Even in typical forms it does not appear that this distinction is clear. *Phyllidia elegans* (see Bergh's Monograph, pl. xix. fig. 1) seems to me to have not "varicositates longitudinales," but groups of confluent tubercles; and, on the other hand, *Phyllidiella pustulosa* strikes me as having not so much tubercles arranged in "quincunces," as compound tubercles arranged in lines. But in abnormal forms, which are frequent, it is still harder to draw the distinction. I have a fine specimen with all the characters of *Phyllidia varicosa*, but the median ridges, though very distinct posteriorly, are broken up in front and unite to form a quincunx as in *Phyllidiella nobilis*. Again, in this latter, the quincunces are often placed so regularly above one another that the tubercles seem to be arranged in longitudinal lines and not in figures. I therefore think it better to abandon *Phyllidiella* as a separate genus.

The arrangement of the dorsal tubercles in these forms is so variable, that it is hard to draw the line between species and varieties, but at least three certainly specific forms occur in East Africa:—

(1) *Ph. varicosa*.—Colour black, blue, and orange; rhinophores yellow. A black stripe on the foot. Tubercles more or less fused into ridges, but not compound. Typically, there are three long ridges down the centre of the back and a number of short ridges, more or less at right angles to them, running inwards from the mantle-edge. Buccal mass yellow and very complicated.

(2) *Ph. pustulosa*.—Black and green; rhinophores black, no black line on foot. Tubercles simple or composed of only two or three lumps. Buccal bulb partly black.

(3) *Ph. nobilis*.—Colour as in *Ph. pustulosa*, but tubercles highly compound, sometimes consisting of ten small lumps fused together. Typically, they are arranged in square or oblong figure. Buccal bulb large, yellow.

That the patterns formed by the tubercles should vary is not surprising, if we consider that the tubercles have always a tendency to unite, and may do so more or less decidedly in a given direction. Thus the typical form of *Ph. varicosa* occurs when the lateral tubercles unite in a predominantly transverse direction. When however, union in a longitudinal direction

predominates, a variety is formed which seems to have five or seven longitudinal rows.

As I have mentioned elsewhere, my observations do not confirm the statements of the older naturalists as to the torpidity and immobility of the Phyllidiadæ, which seem in this respect much like the average Dorid. *Ph. varicosa* is the most active and crawls quite rapidly; *Ph. nobilis* when in captivity crawled continually but slowly; *Phyllidiopsis cardinalis* was sluggish but not motionless.

The Phyllidiadæ are common in the Indo-Pacific, but appear not to be littoral. They are generally found in a few fathoms or in spring-tides at extreme low water.

PHYLLIDIA VARICOSA Lam.

[Bergh, Bidr. til en Monogr. p. 500 f.]

This large, handsome animal is common on the coasts of Zanzibar and the mainland of East Africa. My largest specimen is 73 mm. long and 32 broad, and specimens measuring 50 or 60 mm. are not infrequent. The colour in life is glossy black, with slate-blue ridges on which are bright orange-coloured projections. The rhinophores are bright light yellow. The tubercles are more or less confluent. Down the middle of the back run three ridges bearing 12-16 tubercles. From the sides of the mantle there run inwards about 30 ridges, less uniformly continuous than those in the centre and bearing each two or three tubercles. The openings for the rhinophores and anal papilla are small and placed in tubercles, not on the smooth surface of the back. The tentacles are digitiform and yellowish. The buccal mass is large, yellow, and, as Bergh says, "magnopere compositus." The foot is broad, and bears in the middle a distinct black line 1.5 mm. wide in large specimens. There are sometimes black mottlings at the side of the line. Variations from the typical form are frequent. In one specimen the three longitudinal ridges are all fused together to form a central dorsal prominence, whose tripartite nature is only obscurely visible. In another the three unite in the posterior third of the body, though before it they are separate. In one very fine specimen the three ridges are very distinct behind, but in the anterior third of the body form a group of tubercles like those found in *Ph. nobilis*.

The most distinct variety, however, is one which perhaps corresponds to Bergh's *Ph. fasciolata**, which also comes from East Africa (Comoro Islands), and which he appears to regard as not specifically distinct. It is characterised by having from five to seven ridges on the back, in which the tubercles are more distinct and the connecting-lines less developed than in the typical form. The lateral ridges are almost entirely absent. The rhinophores vary from yellow to grey. The bulbous pharyngeus

* Bidr. til en Mon. af. Phyllidierne, p. 507. "Ph. varicosæ et eleganti forma et characterè dorsi affinis, sed rhinophoriis nigerrimis, varicositatibus dorsalibus (7) sat tuberculosus."

is as in the typical *Ph. varicosa*. This variety when preserved sometimes superficially resembles *Ph. pustulosa*, but I think it should be referred to *Ph. varicosa* because (1) there are intermediate forms; (2) the bulbus pharyngeus is not black; (3) the foot is marked with a broad black line.

PHYLLIDIA (PHYLLIDIELLA) NOBILIS B. (Plate XVI. fig. 1.)

[Bergh, Bidr. til en Monogr. p. 512 ff.; & id. S. R. xvi. 2, p. 860 ff.]

This species is common, but does not attain a large size, the finest specimen being 36.5 mm. long by 18 broad. The back is black, with sea-green tubercles. The under surface and branchiæ are greenish grey, and there is a yellowish border round the foot. The rhinophores are black. The patterns on the back vary considerably, but the ground-plan appears to be in all cases two or three borders running round the mantle and a series of oblong figures in the centre. The tubercles are mostly compound, and sometimes consist of as many as ten small lumps fused together. In one of the most regular specimens there is first a green border showing hardly any traces of tubercles (this feature appears invariable), then a circular band of narrow tubercles, then a similar band of much broader and more composite tubercles. Down the centre of the back are arranged four oblong figures; the sides of each are composed of two tubercles and the top and bottom of one; within the area are two tubercles. All these prominences are compound, but a number of little simple tubercles are scattered here and there. This arrangement varies considerably owing to the borders and figures running into one another. In other cases the central figures are placed accurately one above the other, and the tubercles then appear to be arranged in straight lines. Bergh's uncoloured plates (S. R., Heft xvi. 2, pl. lxxxiv. figs. 11 & 18) give a good idea of the animal, but in my specimens the borders are more distinct and circular. The drawing in Plate XVI. fig. 1, by Mr. Crossland, is a fair representation of the average East-African specimens, though a little less regular than the one described above. It fails, however, to indicate that all the larger tubercles are compound. In many specimens the green parts have a tendency to coalesce and form blotches, but I have never seen this so highly developed as in the animal figured in Bergh's 'Opisthobranchs of the Danish Expedition to Siam' (plate ii. fig. 15).

The openings for the rhinophores and anal papilla are very small and situated in or at the edge of tubercles. The buccal mass is very large and, like the rest of the intestines, yellow, but in some specimens has a little black pigment in front.

PHYLLIDIA NOBILIS, var. ROTUNDA.

Two specimens constitute a very distinct variety, possibly meriting specific rank. From the absence of notes it may,

perhaps, be concluded that the living animals were black and green like ordinary individuals. As preserved, the back is black, with brilliant white tubercles; the under side greyish yellow, the rhinophores black, and the branchiæ greenish; several black bands run from the mantle-edge to the branchiæ on the under side. The tubercles are compound as in the ordinary form but more projecting, and show a few black depressions between the confluent lumps. There are no borders or rings of tubercles round the mantle, but both in the centre and round the margin the tubercles are arranged in square or oblong figures. The buccal mass is large and deep orange. The shape of the whole animal is much broader than usual, being about 23 mm. long by 18 wide, but the end of the foot and mantle are pointed.

If this animal proves to be sharply distinguished from *Ph. nobilis*, it is no doubt a good species, but it will probably be found to be connected with the ordinary form by a series of links. It bears a certain resemblance to Van Hasselt's figure of his *Ph. verrucosa* (v. Bergh, "Die Van Hasselt'schen Nudibranchien," Notes from the Leyden Museum, vol. ix. 1887, p. 313, and plate 6. fig. 7), but does not coincide in details.

Much the same may be said of another specimen in which the tubercles were pink rather than green in life. The three borders and central pattern are very regularly developed as in the typical form described above, but the raised parts are fused into flat, smooth ridges, with hardly any indication of knobs.

PHYLLIDIA (PHYLLIDIELLA) PUSTULOSA (Cuv.).

[Bergh, Bidr. til en Monogr. p. 510 ff.]

I have only two specimens of this form, which would hence appear not to be very common on the East Coast of Africa. It is more elongated than *Ph. varicosa* and *nobilis*, the larger specimen measuring 33 mm. in length and 11 in breadth. The colour of the back is a very deep bright black with green tubercles. The rhinophores and branchial lamellæ are also deep black, but the sides of the body, the foot, and the oral tentacles are slate-coloured. Many of the tubercles, especially in the centre of the back, are compound, and are composed of two or three, rarely four, partly fused together. In the more regular of the two specimens there are three borders of tubercles round the mantle-edge, and three groups, composed of four compound tubercles each, down the centre of the back. These three groups are separated from one another by straight transverse rows composed of three tubercles each. In the other specimens, though the number and character of the tubercles are nearly the same, the pattern is less regular, and the general impression given is of five moderately straight lines down the back. The openings for the rhinophores and anal papilla are rather large, and are placed not in tubercles but on the flat surface of the back. The buccal mass is large; parts of it are yellow, but below and in front it is black.

PHYLLIDIOPSIS CARDINALIS B.

[Bergh, Neue Beiträge zur Kenntniss der Phyllidiaden, Verhandl. der k.-k. zool.-bot. Gesell. in Wien, 1876.]

Four specimens, one from Zanzibar and three from Wasin, were obtained of this form, which has hitherto been recorded from Tonga. One specimen (from Zanzibar) is of considerable size, being 37 mm. long, 15·5 broad, and 13 high. The others are much smaller, being about 15 mm. long and 7 broad. The notes on the living animal say that the larger specimen had the under side, branchiæ, and sides of foot light yellow. On the back were dark reddish-brown blotches bearing black warts alternating with sandy blotches bearing sandy warts, irregularly arranged. Rhinophores dull green, anal papilla bright yellow. The smaller specimens had a lighter coloration. The following are the notes on one of them :—"Ground-colour light yellow. On the under side this is only interrupted by dark green dots along the edge of the foot, and blotches, which are black at their extreme edge, on the mantle. They appear dorsally as black blotches. On the sides of the visceral mass are large black blotches, greenish at the edges, three on one side and two on the other. In the centre of the back are three large reddish-brown blotches. The tubercles are the colour of the blotches on which they occur. Between the red and black blotches is a coarse, clear network of greenish brown. The rhinophores are dark bright green and the anal papilla bright yellow." In the alcoholic specimens all trace of yellow has disappeared, and the general coloration is a dull purplish red with indications of black spots. It would appear that the alcohol liberates the red pigment, which then overpowers the other colour, a phenomenon which I have observed in some preserved Chromodorids.

The general aspect of the preserved specimens resembles *Doridopsis*, the back being covered with pyramidal compound tubercles not unlike those of *D. tuberculosa*, but quite different from those of *Ph. nobilis*. In the largest specimen there are three distinct lines of 8-10 tubercles in the central area, two other lines less distinct, one on each side, and a number of irregular tubercles round the mantle-edge, arranged in two or three lines and decreasing in size outwards. There are also scattered simple tubercles all over the back. The openings of the rhinophores are small and inconspicuous, that of the anal papilla large and circular. The branchiæ are dull red; they run up nearly to the mouth, and are otherwise only interrupted for about 2 millimetres on the right-hand side by the genital papilla. The smaller, and doubtless younger, specimens are very like the large ones, but the tubercles are less developed.

The buccal parts are much as in *Doridopsis*. From the mouth issues a thickish tube with laminated walls inside. It is bent towards the left and back again, and the central nervous system lies at its posterior end. It is 2·5 mm. broad and about 4·5 long, but would be considerably longer if straightened out. From

this issues a much thinner tube, about 5 mm. long and 1.5 broad, with muscular walls. After a sharp constriction it continues again for about 5 mm., and enters the liver rather far back. In the large specimen the posterior part of the tube is much the same size as the anterior. In the smaller ones it is considerably more inflated. A purplish gland lies under the first-mentioned thick portion of the above tract, but is not fused with it as in the other Phyllidiadæ.

DOTONIDÆ.

DOTO AFRICANA, sp. n.

One small specimen found on a Sertularian at Chuaka. The notes on the living animal are as follows:—"Ground-colour of body grey-black with two white stripes; sides of foot also white. Rhinophore-sheaths large, also grey-black. Six pairs of cerata, of which the third is the largest and the fifth and the sixth very small. Cerata yellow-brown, with dark blue tips to the tubercles."

The preserved specimen is 3 mm. long, and has retained its coloration fairly well, though the difference between grey-black and dark blue is not visible. The cerata are relatively large, the tallest being nearly 2 mm. high. They are of the shape usual in the genus. The third pair bears sixteen rounded tubercles, that is four rows of four each; the others have fewer tubercles according to their size, and the sixth pair are simple warts. The rhinophore-sheaths are large and stout, not much broader at the top than at the bottom, the edges of the cavity smooth and not turned outwards. The rhinophores are completely contracted within the sheaths. In front of each sheath lies a tubercle or short ridge, pointing towards the edge of the oral veil, which is large and circular. The anal papilla is yellow, and lies between the first and second cerata on the right side.

The delicate and transparent jaws, though hardly visible, appear to be of the generic type, with smooth edges. The radula consists of a single row of about 70 teeth, of horseshoe-shape, but somewhat more rectangular than usual. The central cusp is well developed, and there were faint indications of two or three denticles on each side of it.

This does not appear to be Bergh's *Doto indica* or his *Doto* sp. (Mal. Unt. 1894, vi. 1, p. 13), and it seems necessary to create a new species, though in the case of so small an animal there must always be some doubt whether it has assumed its mature and specific form. The most distinct character is the presence of two tubercles in front of the rhinophores. Cf. the ridges in *D. fragilis* and *pinnatifida*.

ÆOLIDIADÆ.

FIONA? PINNATA (Eschscholtz).

[Eschscholtz, Zool. Atlas, 1829, p. 14; Bergh, Journ. Mus. Godeffr. Heft ii. 1873, pp. 87-88; id. Beitr. z. Kennt. der Æolidiaden, i. p. 605.]

One specimen was found on a dead nautilus-shell which was

floating between Zanzibar and Prison Island. On the shell were also *Clytia* and a small species of barnacle. The notes on the living animal are as follows:—"Foot colourless and transparent. Upper surface of body has a yellowish-brown tinge, which is deeper on the tips of the cerata. The liver-canals appear as dark greenish brown. The foot projects behind the cerata for some distance. Cerata numerous; they bear on the inside a wrinkled branchial membrane."

The preserved specimen is much bent, and would perhaps measure 20 mm. if straightened out. It is about 5 mm. broad. The general shape is much that of *Fiona nobilis* (= *marina*), as figured by Alder and Hancock, and the foot does not project much behind, as it did in the living animal. The bare space in the centre of the back is not large. On each side is a thick-set longitudinal row of about 60 or 70 cerata. The transverse arrangement is irregular, but in a given line there are generally two or three large cerata, and one or two quite small ones outside. The cerata are somewhat thicker and more inflated than those in specimens of *Fiona nobilis* received by me from Naples. The larger ones bear on the inside a wrinkled branchial membrane, but this is absent on the smaller ones. The pericardial prominence is not conspicuous. The oral tentacles are some distance above the mouth, and the rhinophores point sideways. No eyes are visible. The anal papilla is latero-dorsal, just inside the cerata about halfway down the right side.

The radula consists of 33 horseshoe-shaped teeth, with a large central cusp and six denticles on each side of it. At the base of these main denticles, or between them, are occasional accessory denticles. The jaws are yellowish, with a single row of rather coarse teeth.

I doubtfully identify this form with *F. pinnata*, recorded from the Northern and Central Pacific. In favour of the identification are the facts that the living animal had a projecting tail of some length, though this character is not clear in the preserved specimen, that only the larger cerata have the branchial membrane, and that the teeth have six denticles on each side of the central cusp.

HERVIA LINEATA, sp. n. (Plate XVI. figs. 2 & 3.)

Two specimens from Prison Island, Zanzibar. The following are the notes on the living animal:—"General body-colour a translucent white with a slightly red-brown tinge, which is well marked on the rhinophores, and rather less so on the anterior tentacles and on the sides of the narrow groove-like foot. The body is marked with thin clear lines of opaque white. Cerata in four or five clumps; they are of a chocolate colour, with longitudinal, fine, clear, opaque white lines. Between the rhinophores and tentacles are two brilliant vermilion blotches. The foot is narrow and tapering to a tail."

The preserved specimens are of a uniform dirty yellow, and

the largest measures 8 mm. long by 2 broad. The pericardial prominence is large. The cerata, which are not at all caducous, are set on low inconspicuous ridges in groups as follows:—

	<i>Left.</i>	<i>Right.</i>
First group	8	10
Second „	5	4
Third „	5	5
Fourth „	5	5
Fifth „	3	3

The smaller specimen has only four groups of cerata, as in the Plate XVI. The first group is composed differently from the others, and possibly consists of two fused together. The cerata are longish, but, as preserved, slightly inflated in the middle. The innermost and outermost are smaller and the median ones largest, attaining a length of 2 mm. The tentacles are longer than the rhinophores, which are not perfoliate. The foot is produced anteriorly into tentacular angles.

The jaw bears 20–27 distinct coarse denticles of very irregular shape. There is a single series of 18 teeth, of the form usual in *Facelina*, with a strong central cusp and 10–11 longish, somewhat curved denticles on either side.

I cannot see what is the difference between the genera *Hervia* Bergh (1871) and *Rizzolia* Trinchese (1877), and refer this specimen to the former, since it has priority. But it might equally well be referred to *Rizzolia*.

PHIDIANA TEXUIS, sp. n.

Two specimens from Wasin Island, British East Africa, dredged in 10 fathoms. The notes on the living animal are as follows:—“About half an inch long and very narrow, vermiform. Tail long, but bearing cerata to the tip. These are nearly all lost, but were uniformly vermilion in colour. Foot white, body pinkish, tentacles and rhinophores white. Foot very narrow behind, broader in front, where it is bordered by a flap on either side; grooved in front but not produced into tentacular angles. Tentacles very long and spreading outwards. Rhinophores very slightly ringed in the distal halves, which are opaque, the proximal halves being translucent.” Of a second specimen caught in the same place next day, it is noted that when it was first captured “the cerata looked vermilion and light violet-blue, but subsequently became practically colourless with a bluish bloom. The vermilion liver does not nearly fill the cerata; it is thin and has numerous short more or less horizontal branches. In this specimen the tentacles and rhinophores appear of nearly the same length.”

The preserved specimens are of a uniform dirty yellow, and the largest is 9 mm. long and 2 broad. Both of them have lost nearly all their cerata, and the disposition of these organs is no longer plain, but apparently they were set in five groups, without

counting the small ones on the tail. The cerata are long, cylindrical, and transparent, allowing the ramifications of the liver to be distinctly seen. As noticed in the living animal, these latter are long and thin, with well-developed knobs or short branches. The rhinophores and tentacles are also long and thin; the former bear about 15 rings near the top, but are smooth below. The foot is very narrow, with thin projecting margins: in front it is expanded into a semicircular disk; the anterior margin is grooved, and the corners are rounded.

The jaws, which were examined in all three specimens, were transparent and very delicate. No denticles were to be seen on the edge, and, though it is hard to be certain of their absence in dealing with such slight and colourless material, it is to be observed that they were found without difficulty in other similar forms. The radula consists of a single series of horseshoe-shaped teeth numbering 23, 20, and 18 respectively, in the three specimens. Thin, pointed, lateral denticles extend almost up to the tip of the central cusp: there are as many as 20 on either side, but sometimes the number sinks to 15.

I think these specimens should be referred to *Phidiana*, in spite of the doubt about the jaws, and should form a new species, chiefly characterised by the large number of lateral denticulations on the teeth. Also, the branches of the liver, which in other species are covered with knobs, seem to bear distinct short branches.

FACELINA LINEATA, sp. n. (Plate XVI. figs. 4 & 5; and Plate XVII. figs. 10 & 11.)

Two specimens from Zanzibar.

The notes on the living animal say that it had a general resemblance to *Hervia lineata*, which was caught about the same time, but the colours were brighter, and there was an orange-red ring round each of the cerata near the tip. The rhinophores were jet-black. There were white lines on the body but not on the cerata, and there were three red blotches between the tentacles and rhinophores. The tail was long, and there was a very deep groove along the front of the foot.

The largest of the preserved specimens is 6 mm. long and 2.5 mm. broad, but is evidently much contracted. The colour is a uniform alcoholic yellow, except that the rhinophores are still black. The disposition of the cerata is not quite clear, as many have been lost, but appears to correspond with the drawing. The genital orifices seem to be below and between the first and second group, and the vent after the third. The cerata are longish and cylindrical. The oral tentacles are large and thick, but are clearly much contracted, as are also the rhinophores, the perfoliations on which are not so distinct as might be expected from the drawing of the living animal (Pl. XVI. fig. 4). The narrow foot is expanded at the sides into thin margins, and anteriorly into deeply grooved tentacular processes.

The radula consists of a single series of teeth of the form usual in the genus, with a moderately large central cusp and six denticles on each side, of which the innermost and outermost are the smallest and the median the largest. The jaws bear a single series of 35 rather irregular denticles. The verge is armed with spines.

This appears to be a new species of *Facelina*, but I have not had an opportunity of seeing the description of *F. cyanella* (Couth.), which Bergh refers to this genus with a query.

PHYLLODESMIUM HYALINUM Ehrenb.

[Ehrenberg, Symbolæ Physicæ, series prima, 1831; Bergh, "Anatomisk Undersøgelse af *Ph. hyalinum*," Naturhist. Foren. Vidensk. Meddelelser, 1860.]

One specimen dredged in about 10 fathoms near Wasin.

The notes on the living animal are as follows:—"About one inch long. Body semiopaque, pure white. Rhinophores and tentacles ditto. Rhinophores slightly annulated, shorter than the tentacles. Cerata very long and opaque, so that the liver is not visible; whitish violet in colour; their upper halves and the whole length of the sides are covered with low rounded projections, between which dark-brown pigment is found. The first groups of cerata are almost at the side of the rhinophores, and consist of only two cerata on each side. The remaining cerata are set in seven pairs of clumps of four each, and there is a space between the second and third pairs of clumps. The cerata are somewhat flattened."

The preserved specimen is 10.5 mm. long and 3 broad, with a thread-like tail. Relatively to the size of the animal, the cerata are enormous, the largest being 8 mm. long. They are flattened, rather convex on the outer and concave on the inner face. The edge all round is marked by a line of knobs, which are, however, more numerous at the top than at the bottom. On the outer side the whole surface of the upper half is covered with similar knobs. On the inner side the surface is mainly smooth except at the edges, but at the very top there are a few knobs. The cerata are largest on the inside, and gradually decrease outwards. The smallest appear to have no knobs. The larger are easily detached, and hence the arrangement of groups was not easy to see in the preserved specimen, but it appeared to have been as described in the notes on the living animal. The rhinophores are short and thick, set close together, and annulate. The tentacles are longish and curved. The foot is grooved anteriorly, and produced into moderately long but not conspicuous tentacular angles. The anal papilla is latero-dorsal, just behind the rather large pericardial prominence. The genital openings are under the rhinophores.

The jaws bear five or six coarse denticles, of which three are very large indeed, the others smaller. The radula consists of sixteen colourless teeth, bearing between 30 and 40 denticles on each side. The shape is much as in Bergh's plates (*l. c.*), but the denticles are rather longer.

HERMÆIDÆ.

STILIGER VARIANS, sp. n. (Plate XVI. fig. 6.)

Several specimens from Prison Island in Zanzibar Harbour, found in green-branched seaweed, in which they are practically invisible. The colour was very variable, ranging from dark brown to white, but was as a rule brilliant green. After being kept in captivity for a night, the animals grew perceptibly paler. The main colour was largely hidden, except at the sides of the body and in the centre of the back, by numerous lines of a deeper colour, generally dark bright green, and in some, but not all, specimens there were more or less extensive patches of crimson lake. The form was somewhat elongate, and the maximum dimensions 10 mm. by 2 mm. The foot was fairly broad and green.

The preserved specimens are colourless and semitransparent. They have contracted into an oval or nearly semicircular form, and strongly resemble small tufts of seaweed. The centre of the back is bare, and through its transparent integuments can be seen a great number of circular folliculate organs which are apparently the follicles of the hermaphrodite gland. There are about ten transverse rows of cerata in the largest specimens, containing four (or sometimes five) cerata on each side of the central space. The two innermost cerata of each row are large (about 3.50 mm. \times 2 mm.) and somewhat inflated. The others are very much smaller and look like mere tubercles. They all contain ramifications of the liver, consisting of one large main stem from which spring three or four quite small and short branches. The bladder-like pericardial prominence is somewhat elongate; in front of it and fused with it is the anal tube. The rhinophores are entire and not grooved. In the largest specimen they are about 3 mm. long and rather thick, as if contracted. Below them are two lumps which may be regarded either as a frontal veil notched in the middle, or as rudimentary tentacles. The anterior angles of the foot are not much produced. The tail is pointed but not long.

The radula was examined in several specimens, and was found in all to consist of four or five teeth in the ascending part and six in the descending, while the number in the heap did not seem to exceed six or eight.

The teeth (Pl. XVI. fig. 6) are somewhat like those of *Ercolania siottii* (v. Trinchese, 'Aeolididæ del Porto di Genova,' vol. ii. pl. x. figs. 7 & 8), and have a broad spoon-like hollow into which the tooth behind fits.

In my account of Mr. Gardiner's Nudibranchs ('Fauna and Geography of the Maldive and Laccadive Archipelagoes,' vol. ii. pt. i. p. 571, and pl. xxxii. figs. 9 & 10) this animal is erroneously figured as *Hermæa minor*. It is, however, not a *Hermæa* and not identical with Mr. Gardiner's specimen. That specimen is a *Hermæa*, and may possibly be *H. minor*, as there suggested.

STILIGER IRREGULARIS, sp. n. (Plate XVII. fig. 12.)

Two specimens from Chuaka on the East Coast of Zanzibar, found among Sertularians. The animal had a somewhat peculiar appearance owing to the hinder cerata being about twice as long as those in front and spreading out in a fan-like shape. One specimen was of a translucent white, but the liver, extending in two lines down the side of the body and giving off branches to the cerata, was green, and created an impression that the whole animal was of that colour. In the other specimen the branches of the liver in the cerata were of a dirty yellow, and there was some reddish-grey pigment in the integuments of the body, so that the longitudinal liver-tubes were not easily discernible. Near the head, however, they were distinct and green. The cerata in this specimen had white spots. The animals were less than 2 mm. long.

Only one specimen has been preserved, and its very small dimensions rendered examination rather difficult. In the hinder part of the body there are two longitudinal lines of cerata arranged in five transverse rows on each side, of which the inner are two or three times as long as the outer. In the front part there is a single line of five small cerata, and there are no signs of others having been detached. The cerata are cylindrical, much like those of *Hermæa dendritica*, and not inflated or ovate. Though the surface of the liver-branches is irregular, they do not appear to have distinct secondary ramifications within the cerata. No pericardial prominence is visible. The rhinophores are short and simple; behind them are two very distinct black eyes. The oral veil is circular and not notched. The foot is truncate in front; there were no signs of a groove or tentacular prolongations of the corners.

The radula consists of four teeth in the ascending portion, six in the descending, and a small heap. The teeth are much like those of *S. varians*, but the outline is somewhat simpler and less wavy (Pl. XVII. fig. 12).

PHYLLOBRANCHIDÆ.

[Bergh, in S. R. ii. & xvi.; id. Beiträge zur Kennt. d. Aeolidiaden, ix.; A. & H., Coll. of Nudibr. Moll. made in India, p. 145; Trinchese, Aeolididæ del Porto di Genova, 1881; Pelseneer, Recherches sur divers Opisthobranches, 1894, pp. 50-52.]

This remarkable family, which is characterised by its flat leaf-like dorsal papillæ, consists of three genera, *Phyllobranchus*, *Cyerce*, and *Caliphylla*, of which the first two are recorded from the Indo-Pacific (but *Ph. viridis* from the West Indies), and the last from the Mediterranean. They all agree in having flat leaf-like cerata, an ascoglossan radula and a buccal crop, complicated reproductive organs, and (except *Caliphylla*) oral tentacles as well as rhinophores. *Cyerce*, though very like *Phyllobranchus*

superficially, presents many points of difference and is certainly not a mere subgenus, as it is considered by Fischer (Manuel de Conch. p. 343). Externally the chief difference is that the foot in *Phyllobranchus* is, as usual, an undivided surface, whereas in *Cyerce* there are two distinct parts separated by a transverse division. In *Phyllobranchus* the buccal crop is long and twisted, the vent lateral, and the teeth are preserved in a spiral. In *Cyerce* the crop is flat and oval, the vent dorsal, and the teeth are preserved in an irregular heap. The digestive organs also present important differences, the chief of which is that whereas in *Phyllobranchus* (and in *Caliphylla*) the liver is ramified within the dorsal papillæ, in *Cyerce* it appears not to enter them at all and to be wholly contained in the body-cavity.

The function of the large buccal crop is obscure. It would appear that, as a rule, this organ is only found when the radula is uniseriate (ascoglossan) or very narrow (*Lamellidoris*, *Goniodoris*, &c.), and when there are no jaws. On the other hand, its presence under these conditions does not appear to be necessary (*e. g.* *Elysiadæ* and *Hermæidæ*).

PHYLLOBRANCHUS PRASINUS B.

[Bergh, in S. R. Heft ii. pp. 52-87.]

Fourteen specimens from Chuaka on the East Coast of Zanzibar, mostly about 3 centimetres long, but two much larger, measuring over 5 centimetres in life. The animals were found at low tide. The colour is described as transparent, with small green branching lines on the cerata, giving on the whole an effect of greyish green. It was noticed that the cerata break off easily when the animal is disturbed, and retain the power of independent movement for some time.

The preserved specimens have kept their colour fairly well, but many of them show a yellowish rim round the cerata, not mentioned in the description of the living animal or by Bergh. The yellow spot on the cerata mentioned by Semper is not visible.

The largest preserved specimen, which has lost nearly all its papillæ, is 47 mm. long and 14 broad. The head is separated from the body by a sort of ridge, which descends and forms lappets on each side of the mouth. The oral tentacles are undivided, about 7 mm. long, and slightly grooved. The rhinophores are bifid; the main branch measures 12.5 mm. and the side branch 5.5. Both branches are grooved and also the common stem, but less distinctly. The rhinophores seem larger than in Bergh's specimens; in one specimen only 25 mm. long they measure 12 mm. At the base of the rhinophores the black eyes are clearly visible. The pericardial prominence lies 14 mm. from the anterior margin. The opening for the penis is immediately behind the right tentacle. The large female genital papilla is a little further back on the right-hand side, under the rhinophores. Still further back is the large, cup-shaped, anal papilla, under the anterior end of the pericardial prominence. The foot has thin

wide lateral margins and a tail 9 mm. long; the anterior margin is thick, distinctly, but not very deeply, grooved, and produced into tentacular expansions at the corners. The centre of the back is bare, with small irregular tubercles, whose number varies greatly in different individuals. The sides are covered with cerata, which extend right up to the lappets of the mouth. They are easily detached, and all the specimens have lost many, but they appear to be arranged in four longitudinal rows on each side, with a few very small extra ones at the extreme outside. They consist of an oval plate set on a short stalk; at the junction of the plate and the stalk is generally a small funnel-like depression. The edges of the plate are smooth and not denticulate, as in Bergh's specimens. On the inner surface are a number of lines bearing small yellowish tubercles. These lines spring from three main trunks, but subdivide, so that there are 10-15 at the edge. The largest papillæ are those on the inside nearest the centre of the back. In fine specimens the stalk is about 2 mm. high and the plate 7 long and 6 broad.

The anatomy of this remarkable animal has been described by Bergh (*l. c.*) with such elaborate thoroughness that a further account is hardly necessary, although the function of some of the internal organs is not clear. Both the digestive and reproductive systems are extremely complicated. The buccal mass is large (8.5 by 5 mm.) and striped. The radula is of the ascoglossan type, the teeth being preserved in a regular spiral, not a heap. Only two or three teeth are in use at a time, but the total number varies between 40 and 50 in large specimens. The shape of the teeth is as described by Bergh, not elongate, with an indentation in the back, and 12-14 squarish denticles on the edges. The digestive apparatus including the large crop (which measured 35 mm. by 2 mm. when straightened) was as described by Bergh; but although I was able to follow the "Seitengallengänge" for a considerable length, I did not succeed in seeing that they form a complete circuit and unite behind. It seemed clear that the hepatic system resembles that of the *Aeolids*, and is ramified within the cerata.

Though there is no sufficient reason to regard these specimens as specifically distinct from *Ph. prasinus* B., points of difference (such as the shape of the cerata, the length of the rhinophores, and perhaps the coloration) are not wanting, and may indicate a distinct variety.

CYRCE ELEGANS B.

[B. in S. R. Heft ii. pp. 99-113.]

Three specimens from Chuaka. Mr. Crossland says of the living animal:—"The foot and central part of the body are white, the sides of the body being dull green (? liver). Cerata very delicate and colourless. Head, rhinophores, &c. translucent white."

The preserved specimens are colourless, with semitransparent integuments which allow the internal organs to be seen, particu-

larly a large folliculate mass which covers the sides and part of the centre.

The largest specimen is 20.5 mm. long and 11 broad across the back. The general construction of the head-parts is as in *Phyllobranchus*, with the dividing line running down and forming lappets by the mouth, grooved oral tentacles, and grooved bifid rhinophores about 4 mm. long. At the base of these latter can be seen the large black eyes. The genital openings are as in *Phyllobranchus*, but the intestine terminates dorsally in a cylindrical tube set in front of the pericardium and slightly to the right of the median line. The foot is in two divisions, of which the anterior is the wider, being 17.5 mm. broad by 7.5 in the longitudinal direction of the body, whereas the posterior portion is 12 mm. long by 9.5 at its broadest part. Except for this division, the foot is as in *Phyllobranchus prasinus*, but the corners of the anterior margin are not much produced. Nearly all the papillæ have fallen off, but it appears that they were arranged at the sides of the back, leaving the centre bare. The largest are about 5 mm. high and 3.5 broad. Though they taper towards the base, they have not a distinct stalk. On their margins are 8-10 yellowish spots. The anatomy of this species, like that of *Phyll. prasinus*, has been elaborately investigated by Bergh (*l.c.*), but the structure of the hepatic system is obscure. In my specimens most of the papillæ are quite transparent, and it seems clear that they contain no hepatic branches, and when they are held out from the body the folliculate mass, which I take to be the liver and which is distinctly visible, is not seen to send any prolongations into their transparent bases. On the other hand, the folliculate mass adheres to the sides of the body-wall in the neighbourhood of the papillæ, which it does not do elsewhere, and must be in immediate contact with the openings at their bases. Within the papillæ are round bodies which look like minute bubbles, and in some cases it seemed that these bubbles were connected by a system of colourless canals. I have unfortunately no means here (East Africa) of preparing sections for microscopic examination.

The radula consists of elongated teeth as figured by Bergh (*l.c.* pl. xv. figs. 5-11), each bearing 12-17 denticles, but the number of teeth seemed less, and was 14+9 in one specimen and 17+10 in another. The second figure in these expressions represents the teeth which have fallen down into an irregular heap, and this heap was much smaller than that described and figured by Bergh, possibly in consequence of the youth of the specimens.

ELYSIADÆ.

PLACOBANCHUS OCELLATUS Van Hass. = PL. ARGUS B. (Plate XVII. figs. 13 & 13 a.)

[B. in S. R. iii. pp. 147-165, and id. Danish Exp. to Siam, Opisth. pp. 180-181.]

Two specimens from Prison Island, Zanzibar Harbour. The larger measured 30 mm. in length, and 15 in breadth when the

sides were folded over the body, but 23 when they were extended. The ground-colour was mainly whitish, but on the dorsal surface this was almost entirely hidden by the numerous dark green branchial ridges. The outer surface of the lateral expansions was sandy coloured with darker spots, and on the foot were many irregularly-arranged deep black spots. Along the junction of the lateral expansions and the foot ran a line of violet rings, and there were four or five more on the forehead. The inside of the furrowed rhinophores was violet, as was also the end of the body. The animal secreted a very abundant mucus.

In the preserved specimen the branchial ridges are very large and distinct, being as much as 1.5 mm. high. There are about 36 main folds, and smaller ones in between. The buccal mass is small, only about 1.5 mm. long, and the crop half that length. The teeth are exactly as figured by Bergh, with about 12 denticles on the margin, but are less numerous than in his specimens. In the radula I found 15 and 14 respectively, and in the heap at the bottom about 40 and 50.

Two pencil drawings by Mr. Crossland are reproduced because they show the animal in a somewhat different attitude from that in which it is ordinarily represented.

ELYSIA FAUSTULA, B.

[B. in S. R. iv. pp. 186-190.]

One specimen from Wasin, East Africa.

There are unfortunately no notes on the living animal.

The preserved specimen is very flat and crinkled, surprisingly like a planarian in appearance, and also somewhat resembling *Tridachia*, but the wings show no signs of being joined behind the neck. The length is 19 and the breadth 16 mm., but the form has become somewhat contorted, and these measurements represent at least 25 and 20 if it were straightened out. The colour is a uniform pale yellowish grey, with a very distinct deep black border all round the edge, and a few scattered black dots on both the upper and lower surface. There are three black dots on the pericardial prominence, and the anterior margins of the tentacular groove are black. There is a fine furrow dividing the foot transversely just below the point where the wings arise, behind which the foot is not clearly differentiated from the sides of the body. The anterior margin of the foot is not expanded into tentacular processes. From the rather large pericardial prominence issue three vein-like ridges on each side. The two anterior pairs are simple and have only very slight ramifications near the edge of the wings. The third pair soon divides into three main branches, which have one or two secondary ramifications. The tentacles are rather large and broadly opened.

The radula consists of 17 teeth, besides which there is a heap of about ten disused ones. The shape is exactly that given in Bergh's plates (in S. R. iv. pl. xxii. figs. 15-17), elongate, and with no trace of denticulations.

I think this specimen may be certainly referred to *E. faustula* B.,

recorded from the Philippines. The specific characters appear to be the coloration, the planarian-like shape, and the elongate smooth teeth.

ELYSIA MARGINATA Pease. (Plate XVI. figs. 7 & 8; and Plate XVII. fig. 18.)

[Pease, Amer. Journ. of Conchology, 1871, vol. vi. p. 304; cf. Bergh, Jour. Mus. Godeffroy, Heft ii. 1873, p. 80, on *Elysia nigrocincta*.]

The following are notes on living specimens captured at Zanzibar:—

1. "Extreme length 1.5 cm. General colour a dull green, but on the surface are opaque black and white spots. The tentacles and edges of the wings are bordered with orange-yellow, white, and on the extreme edge black. The white line is irregular. Internally the edges of the wing are blotched with white. Each black spot has a corresponding orange spot just beneath." (*Vide* figures 7 & 8, Pl. XVI.)

2. "In a second specimen the orange line round the wings was much broken, perhaps a step towards its disappearance."

3. "Rather more than an inch long, when fully extended. Tentacles and wings edged with a double border of orange and black, which is interrupted at the neck. Whole body spotted with small black flecks. Head and auriform tentacles very large. Pericardial bulb prominent. Inside of wings not striated, but the veins can be seen beneath the skin."

4. "Green, without black spots, but wings bordered with a double line of orange and black. Length about one inch."

Unfortunately, only the second and fourth of these specimens have been preserved.

As preserved, the latter is 11 mm. long and 6 high, the wings being raised, not spread out, but applied to one another. The colour is olive-green: the borders have disappeared, but the outside of the wings is covered with numerous yellowish-white spots, and there are a few inside. The tentacles are short and thickish, with traces of black about the groove. The wings are rather thick, not much indented at the edges, and the posterior expansion is not ample. The pericardial prominence is distinct, and the anus lies to the right side of it. The inside of the wings is smooth and does not bear ridges, but where the animal is sufficiently thin to be transparent, veins can be seen radiating from the pericardium.

The foot is not distinctly divided from the body, and the front part is hardly differentiated from the rest. The radula consists of 14 teeth, and there are about 12 more of very varying sizes lying in a heap. The teeth are as in Bergh's plates of *E. nigropunctata* (l. c. pl. xi. fig. 10* and pl. xii. 1), but seem somewhat more slender. There is no trace of denticulation.

The second specimen is 7.5 mm. long, 7 broad when the wings are

* There seems to be a mistake in the explanation of this plate, figs. 13-26 apparently referring to *Cyerce* and not to *E. nigropunctata* as stated.

spread out, and 4·5 high when they are closed and folded together. The colour is yellowish green with black spots within and without, the borders having disappeared. The shape and other external characters are exactly as in the specimen just described. The teeth are also similar but a trifle more bent: there are 16 in the radula, and about 15 of various sizes in the heap.

I think these specimens must be referred to *Elysia* (*Pterogastron*) *marginata* Pease, although his description is somewhat deficient in details. In view of the fact that the teeth of the animal examined resemble those of *E. nigrocincta*, as described by Bergh, and that the coloration is clearly very variable, it is probable that both *E. nigrocincta* and *marginata* are varieties of a protean species ranging from green spotted with black, but without a coloured border, to green with or without black spots, and a more or less continuous single, double, or triple border.

ELYSIA DUBIA, sp. n. (Plate XVII. figs. 14–17.)

Four specimens from Chuaka, found on *Zostera* at low spring-tides. The animals were dark green with a few spots of dull, light blue. They were about 6 mm. long and 3 broad when at rest, but when crawling become narrower and more elongated. They can also swim on the surface of the water foot uppermost.

As preserved, the specimens are of a uniform dark green, and have somewhat the appearance of a minute *Aplysia*, as the wings do not reach to the end of the body but terminate separately, leaving a distinct tail. The tentacles have become mere knobs, but were apparently of a fair size in life. The foot is very distinctly divided from the body by a ridge. The pericardium is continued into a long median ridge down the centre of the body. At about the point where the wings end it bifurcates. From each side of this central ridge issue seven or eight vein-like ridges, much as in *Placobranchus*. The radula consists of 14 teeth and about 20 in the heap; they are elongate and slender. The basal part is nearly as long as the hook and there are no denticulations.

The specimens are perhaps immature.

If *Elysiella* is regarded as a separate genus, these specimens should probably be referred to it, but Bergh (Beitr. zur Kenntniss der Aeolidiaden, viii. 1886, p. 17) seems doubtful as to the validity of the genus and its definition. For the present I think it simpler to refer this form to *Elysia*.

EXPLANATION OF THE PLATES.

PLATE XVI.

- Fig. 1 *Phyllidia nobilis*, dorsal view (p. 282).
2. *Hervia lineata*, dorsal view (p. 286).
3. " " one of the cerata.
4. *Facelina lineata*, dorsal view (p. 288).
5. " " one of the cerata.
6. *Stiliger varians*, three teeth (p. 290). The outline of the middle tooth is coloured red for distinctness.
7. *Elysia marginata*, dorsal view with wings open (p. 296).
8. " " dorsal view with wings closed and body elongated

PLATE XVII.

- Fig. 9. *Madrella ferruginosa*, central tooth (p. 269).
 10. *Facelina lineata*, side view of anterior end (p. 288).
 11. " " ventral view of anterior end.
 12. *Stiliger irregularis*, tooth (p. 291).
 13, 13 a. *Placobranchius ocellatus*, dorsal views (p. 294).
 14. *Elysia dubia*, wings open (p. 297).
 15. " " wings closed and body elongated.
 16. " " crawling foot uppermost on surface of water.
 17. " " teeth.
 18. *Elysia marginata*, teeth (p. 296).

3. On a small Collection of Freshwater Entomostraca from South Africa. By ROBERT GURNEY, B.A., F.Z.S.

[Received June 21, 1904.]

(Plate XVIII.*)

The collection which I describe here was kindly entrusted to me to work out by Prof. Jeffrey Bell on behalf of the Natural History Museum. The specimens were partly mounted on slides and partly contained in tubes, and were collected by Major E. Eckersley, R.A.M.C., from a water-hole on the veld at Kroonstad, O.R.C. This water-hole was a collection of surface-water, quite dry in ordinary weather but filled up by thunder-showers.

Unfortunately very few specimens were preserved, but the few that there are seem of sufficient interest to deserve description, especially as so little is known at present about the Entomostraca of South Africa. Of the seven species collected, only three have been previously described; of the other four, three are apparently new and one is represented by only a single mutilated specimen.

The following is a list of the species:—

PHYLLOPODA.

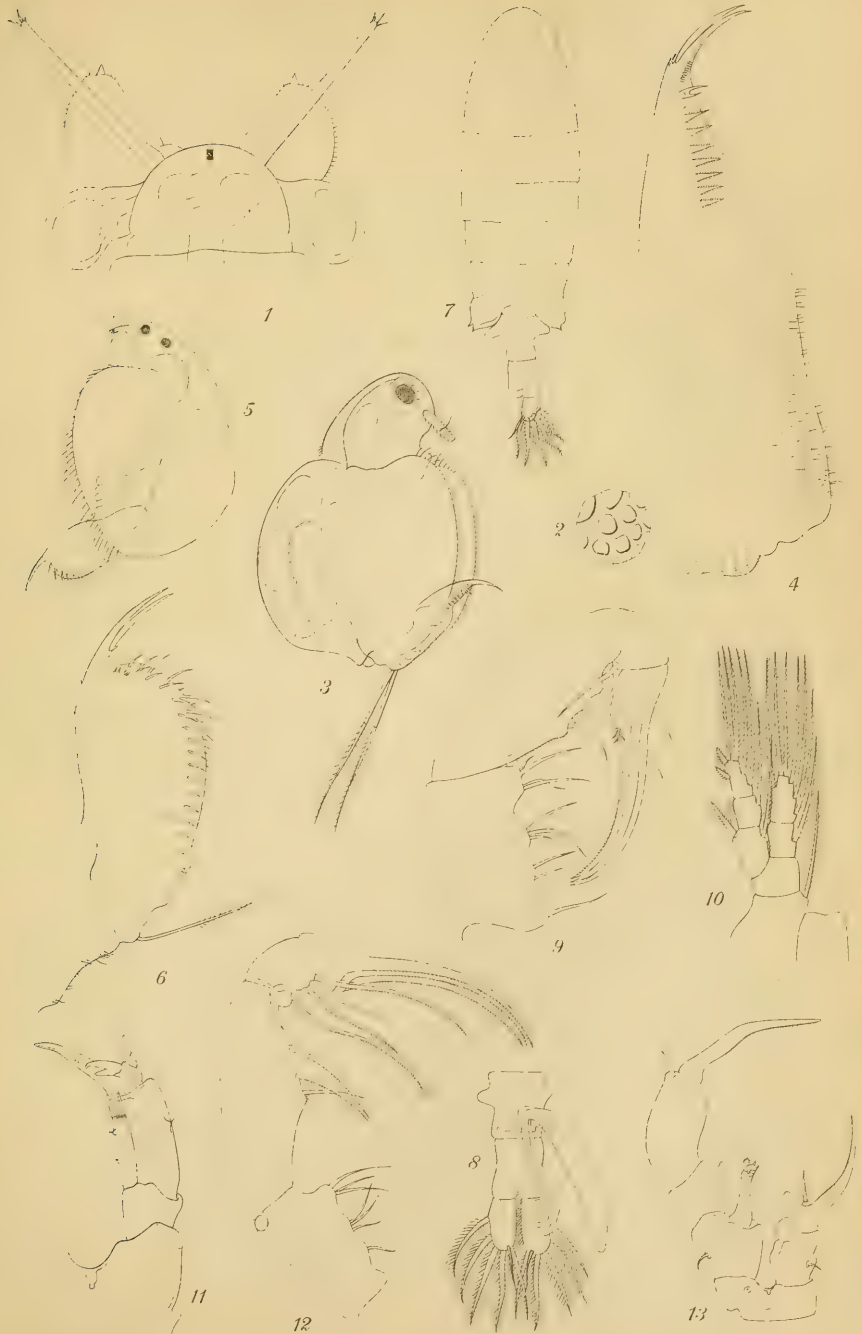
Fam. BRANCHIPODIDÆ.

STREPTOCEPHALUS DREGEI, G. O. Sars. (Plate XVIII. figs. 1, 2.)
 Sars, Arch. f. Math. og Naturv. xxi. no. 4, 1899, p. 19.

Of this species three males and three females were included in the collection. The male only has as yet been described, so that I will give a short description of the female.

Female.—Body slender; thoracic region as long as the caudal region exclusive of the caudal rami, which are long and densely fringed with ciliated setæ. Superior antennæ long and slender; inferior antennæ considerably shorter than the superior, foliaceous, the tip truncated and with a short conical process. Marsupium not reaching beyond the second caudal segment: in one specimen it contains a single row of eggs, each enclosed in a thick capsule with conspicuous more or less polygonal markings (fig. 2).

* For explanation of the Plate, see p. 301.



E. Wilson, Cambridge.

Total length 14 mm.; thorax 7 mm.; caudal rami 3 mm.

The caudal rami of both sexes are stated by the collector to have been red during life.

One of the male specimens is 25 mm. long—very much larger than Sars's two specimens, which measured 16 mm. only.

Fam. LIMNADIIDÆ.

ESTHERIA ELIZABETHÆ G. O. Sars.

Sars, Arch. f. Math. og Naturv. xx. 1898.

The collection included several specimens of this species, both male and female.

While agreeing in all essential particulars with the description given by Sars, the females differed in having no cilia upon the base of their caudal claws.

Fam. LIMNETIDÆ.

LIMNETIS WAHLBERGI Lovén.

Lovén, K. V.-Akad. Handl. 1845, p. 203.

The specimens examined were all females.

CLADOCERA.

Fam. DAPHNIDÆ.

MOINA BELLI, sp. n. (Plate XVIII. figs. 3, 4.)

Dorsal margin of head evenly rounded, without any concavity above the eye; ventral margin somewhat protuberant; posterior margin finely ciliated. Fornix well developed and extending over the eye.

Shell without any trace of striation; ventral margin setose for about two-thirds of its length. First antennæ ciliated all over. Tail of the usual shape, with eight lateral teeth, the first of which is bifurcated. Between the bifurcated tooth and the first simple tooth is a minute elevation covered with cilia, which may represent a rudimentary tooth. Apical claws armed with a basal row of secondary denticles and with a ventral chitinous expansion cleft into teeth. Posterior dorsal surface of tail provided with cilia, which are more or less arranged in transverse rows. Ephippium reticulated all over and containing two resting eggs.

Length 1.7 mm.

Several specimens of this species were contained in the collection, but all were females, one of which was ephippial. The species very much resembles *M. wierzejskii* Richard, and perhaps should be regarded as only a variety of that species. It is mainly distinguishable by the ciliation of the head and first antennæ, and by the structure of the postabdomen.

DAPHNIA sp.

One of the slides in the collection was unfortunately broken in transit, and from the debris I separated the dried and crumpled body of a *Daphnia*. It is, however, impossible to make out more than that it belongs to the *Daphnia magna* group, with a much pointed head and a very well-developed fornix.

Fam. LYNCEIDÆ.

LEYDIGIA AFRICANA, sp. n. (Plate XVIII. figs. 5, 6.)

In general appearance very like *L. acanthocercoides*. Rostrum short and acute. Shell showing faint striation. Eye very slightly larger than the ocellus (fig. 5). First antenna shorter than the rostrum. Tail closely resembling that of *L. acanthocercoides*, but differing from it in the presence of a minute tooth at the base of each of the terminal claws, and in the arrangement of the spines and cilia. In *L. africana* only the first seven spines have accessory spines at their base and the dorsal margin of the tail is not evenly ciliated, but is provided with a few very small spines (fig. 6).

Length 54 mm.

Four specimens of this small species are included in the collection, and it is stated by the collector to have been "not at all common." It differs mainly from *L. acanthocercoides* in its small size and in the relative proportions of the eye and ocellus, which are practically the same size.

COPEPODA.

Fam. CENTROPAGIDÆ.

LOVENULA MEA, sp. n. (Plate XVIII. figs. 7-13.)

Female.—Body slender, with the anterior segment tapering evenly; lateral lobes of last segment expanded, symmetrical, and armed each with two minute spines. Tail consisting of two segments only, the anterior one produced laterally into lobes which are asymmetrical. Caudal rami armed with five strong ciliated setæ, and a slender one springing from the dorsal surface between the two innermost terminal setæ; inner edges of the rami ciliated. Posterior antennæ with outer ramus slightly longer than the inner, but in other respects exactly as in *Lovenula falcifera* (Lovén). Posterior maxillipedes very closely resembling those of *L. falcifera*, but the terminal part is distinctly composed of four joints instead of three. The second basal joint bears terminally a small lobe armed with two setæ. In *L. falcifera* two of the strong terminal spines are borne upon the penultimate joint, and the third upon a small terminal joint, whereas in the present species each is borne upon a separate joint. The swimming-legs agree in all respects with those of *L. falcifera*.

4. On the Morphology and Classification of the *Asellota*-Group of Crustaceans, with Descriptions of the Genus *Stenetrium* Hasw. and its Species. By H. J. HANSEN, Ph.D., F.M.L.S.

[Received October 17, 1904.]

(Plates XIX.-XXI *.)

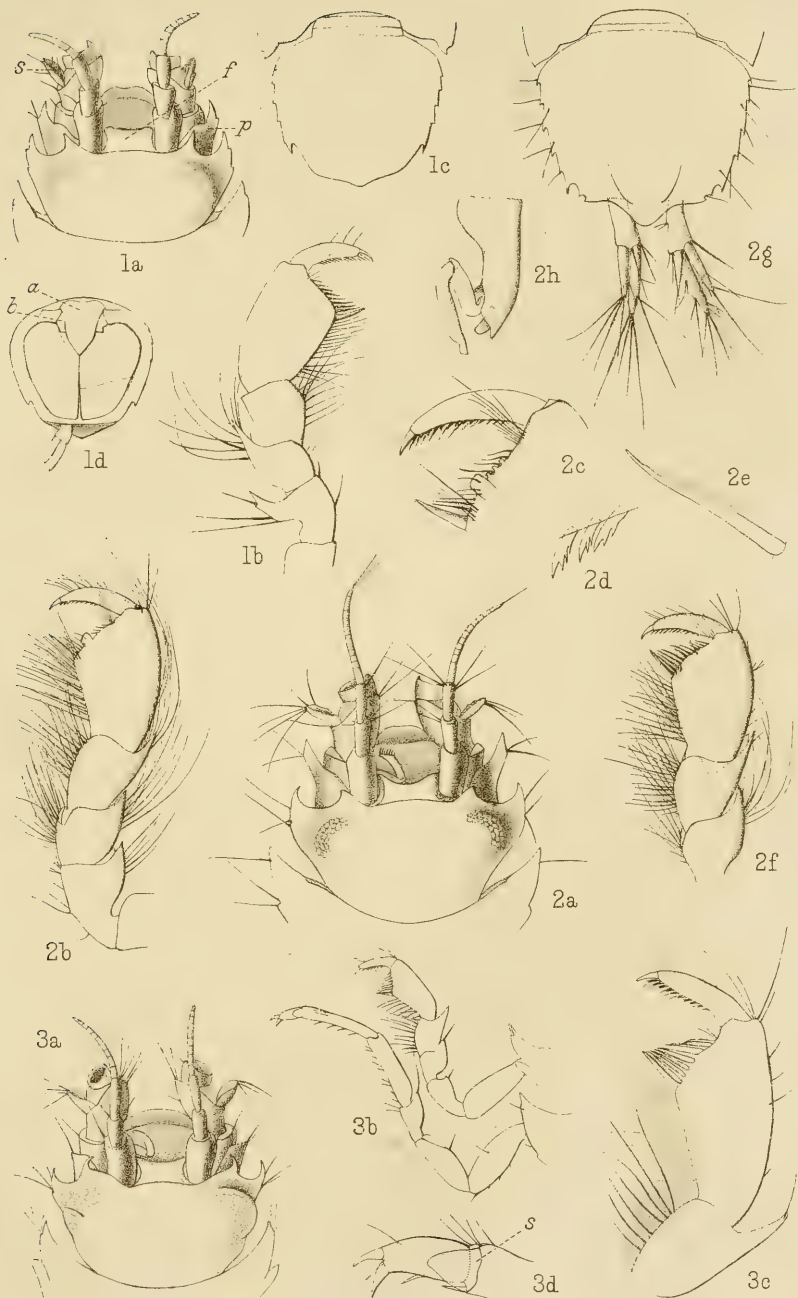
I. *Introductory Remarks.*

The tribe or suborder *Asellota* is in some respects one of the most varied and, as to the number of species, probably by far the richest of all groups of pre-eminently marine Isopoda. A perusal of the portion in question of Beddard's account of the 'Challenger' Isopoda (Zoology, vol. xvii.), and of G. O. Sars's 'An Account of the Crustacea of Norway,' vol. ii. Isopoda, 1896-99, conveys a fair idea as to the striking differences in general aspect and in some structural features between the numerous genera, among which we find such types as *Asellus* Geoff., *Ianira* Leach, *Munna* Kr., *Dendrotion* G. O. S., *Macrostylis* G. O. S., *Ischnosoma* G. O. S., *Desmosoma* G. O. S., *Munnopsis* M. Sars, *Eurycope* G. O. S. In the work named, Sars describes 42 species referred to 21 genera; Beddard has established 32 species referred to 15 genera, and 8 of these genera are not found in Norway. In order to furnish an instance showing how much remains to be known, I may perhaps state here that from the seas around Greenland, Iceland, and the Færoe Islands, the Copenhagen Museum possesses more than 90 species, of which at least 60 are new to science; the major part of these new forms were secured by the 'Ingolf' in depths between 300 and 1870 fathoms.

Sars refers his 21 genera to five families, but it will be shown below that four of these are almost artificial, as really good characters for their separation are wanting. But this distinguished author has produced a vast number of good figures—with useful descriptions—of all his forms and of details of their dermo-skeleton; moreover almost all really important genera hitherto established of *Asellota* have been incorporated in his fine work. For these reasons I can often, in the following discussion, refer the reader to his figures as proofs and illustrations for my remarks.

Among the genera not represented in the Norwegian fauna, *Stenetrium* Haswell is the most aberrant and important. Of this genus five species have been established by four authors, but our knowledge of several essential points of its structure, especially of the pleopoda, is still imperfect. Most of the figures of *S. antillense*, sp. n., were drawn by me more than fifteen years ago, but publication was, however, postponed, which proved to be fortunate, as new and interesting species have been received in

* For explanation of the Plates, see p. 330.



H.J.Hansen del.
E.C.Knight lith.

West, Newman imp.

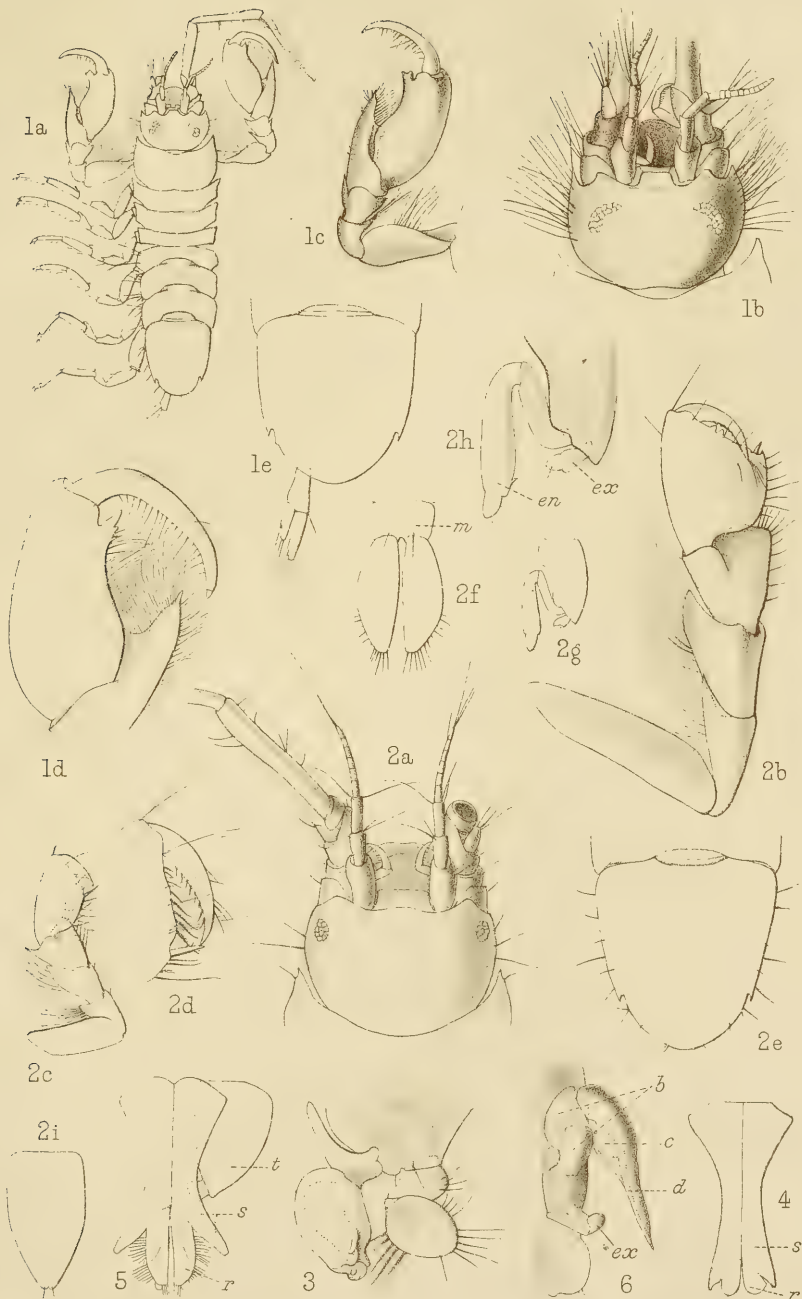
1. STENOTRITIUM ARMATUM Hasw. 2. S. MEDITERRANEUM n.sp.
3. S. SERRATUM n.sp.



H. J. Hansen del.
E. C. Knight lith.

West, Newman imp.

1. STENOTRITIUM SERRATUM *n.sp.* 2. S. OCCIDENTALE *n.sp.*
3. S. ANTILLENSE *n.sp.*



H. J. Hansen del.
E. C. Knight lith.

West, Newman imp.

1. STENETRIUM ANTILLENSE *n.sp.* 2. S. SIAMENSE *n.sp.*
3-6. VARIOUS ASELOTIA.

later years. In the following pages I describe six species examined by myself of this type, five of which are considered new to science. Having now such a rich material of an important and imperfectly known genus at my disposal, I thought it appropriate to work it out; besides, I seize the opportunity of elucidating some points of the morphology of the pleopoda in other Asellota, and discussing the classification of the whole group.

II. *Description of the Genus Stenetrium Hasw.*

Body oblong, three or four times as long as broad, rather depressed, shaped nearly as in *Ianira*.

Head with the dorsal surface much broader than long; in advance of the anterior margin is seen a transverse area, the frontal plate (Pl. XIX. fig. 1 *a*, *f*), between the insertions of the antennulæ. When the head is stretched forward a large, sloping, anteriorly rounded part is seen in advance of the frontal plate; this area is clypeus and labrum, and when the mandibular palps are in their natural position the distal part of their second joint and the whole third joint are observed on the surface of the clypeus. Eyes always distinct, but varying much as to shape, size, and situation.

Antennulæ from somewhat shorter to a little longer than the breadth of the head. Peduncle three-jointed; basal joint oblong but rather thick, longer and much thicker than any of the two others. Flagellum varies much in length and number of joints.

Antennæ nearly as long as or a little longer than the body, very similar to those in *Ianira*. The peduncle consists of four short and two long joints: the first joint is always well developed (and shows excellent specific characters); third joint on the outer side with an exopod which is a subtriangular, oblong, setiferous plate, with the lateral parts bent inwards.

Mouth-parts essentially as in *Ianira*. Mandibles (Pl. XX. fig. 3 *a*) moderately long; lacinia mobilis of the left mandible (fig. 3 *b*) consists of a thick, long, movable process and a few very broad, long, a little curved setæ, pectinate with exceedingly short teeth along their anterior margin; one of these setæ proceeds from the process itself near its base; the articulating membrane is broad on the lower side. Lacinia mobilis of the right mandible (fig. 3 *c*) shows a number (in *S. antillense* about ten) of very thick setæ, nearly all with saw-teeth. Mandibular palp well developed, three-jointed; terminal joint rather broad and long, with a comb of numerous fine setæ. Hypopharynx (paragnatha) (Pl. XX. fig. 3 *d*) rather deeply bifid; each half has the inner margin nearly straight and clothed with fine bristles on its distal part; the anterior angle rather rounded and the outer margin very convex.—Maxillulæ (fig. 3 *e*) slender; the inner lobe terminates in three curved, thick, plumose setæ; outer lobe (fig. 3 *f*) with a good number of very thick, curved spines, coarsely serrate along at least one margin. Maxillæ (fig. 3 *g*)

nearly as long as the maxillulæ, rather slender; the lobe from the second joint oblong, as long as the two lobes from the third joint. Maxillipeds (fig. 3 *h*) large; second joint—the lobe not taken into consideration—very large, more than twice as long as broad, its lobe, which is marked off by a transverse suture, is large, longer than broad, with several small hooks at the inner margin, while the distal margin is cut off and furnished with several short setæ, some of which are very broad, scale-like; fourth and fifth joints rather expanded; the two distal joints slender. Epipod very long, about three times longer than broad. Basal joint in the adult female without any leaflet directed into the marsupium.

Thorax shaped nearly as in *Ianira*; anterior lateral angle of first segment always produced into a triangular, acute, flat process directed forward*. First pair of legs terminates in a prehensile hand, the sixth joint being large, compressed, with the palmar margin armed with processes or remarkable spines or setæ, while the seventh joint together with its short terminal claw is slender and claw-shaped; this hand shows sometimes rather little, but often a highly developed, sexual difference, being frequently not only much larger in the adult male than in the female, but of quite another shape. The six other pairs of legs essentially as in *Ianira*; seventh joint terminates in a claw, beneath which a spine of the same size is seen. Marsupial lamellæ four pairs, proceeding from first to fourth pair of legs.

Abdomen essentially as in *Ianira*; two rudimentary segments are observed in front of the large abdominal shield; the latter has at the end of each lateral margin a small notch, the outer margin of which is formed by a sharp triangular tooth.

Pleopoda are exceedingly characteristic†. In both sexes the third pair is only to a very small extent (Pl. XIX. fig. 1 *d*) covered by the first pair (in the female) or the two anterior pairs (in the male); its sympod is rather small, quadrangular (Pl. XX. figs. 2 *i* and 2 *n*); the two-jointed exopod is exceedingly large, scarcely respiratory, and covers the respiratory endopod, which is unjointed and several times smaller; the inner margin of each exopod is straight, and the two exopods touch each other along the mesial line, constituting together a kind of operculum which covers the lower surface of abdomen, with the exception of a moderately broad margin at the sides and behind, and a small portion in front occupied by the anterior pleopoda. In the female the pleopoda of the first pair are completely fused (Pl. XX. fig. 2 *m*; Pl. XXI. fig. 2 *i*), constituting a subtriangular more or less oblong operculum, which is at least three times smaller than an exopod of the third

* According to Haswell this process is wanting in *S. inerme* Hasw., but in the sequel it is shown that this species probably does not belong to the genus *Stenetrium*.

† In Section V. of this paper the comparative morphology of the pleopoda in the Asellota is discussed; in this account of *Stenetrium* and in Sections III. and IV. the structure of the pleopoda is described and the interpretations applied without explanations.

pair of pleopoda. Second pair is wanting, as in all Asellota. In the male the first pair (Pl. XX. fig. 2*g*; Pl. XXI. fig. 2*f*) is slightly longer and at the base narrower than the female operculum; the sympods of the two appendages are completely fused with each other, forming a short, transverse plate; each pleopod has one ramus, which is free, oblong, and between two and three times longer than the sympod; each ramus can be moved a little by a tiny muscle (*m.*) in the sympod. The second pair is a good deal smaller than the first; each appendage (Pl. XX. fig. 2*h*; Pl. XXI. fig. 2*g*) consists of an oblong subtriangular plate, the sympod, the inner margin of which is sinuate, and from the distal end of this margin arise the two rami. The exopod is very small, slender, a little curved, scarcely hook-shaped, one-jointed, but in *S. siamense* (Pl. XXI. fig. 2*h*, *ex.*) a vestige of a division into two joints is observed. The endopod is rather long, very slender, two-jointed, and strongly geniculate in the articulation (Pl. XXI. fig. 2*h*, *en.*); the proximal joint contains a muscle for the movement of the second, which has no internal cavity, while its end is obtuse and often furnished with a brush of exceedingly short bristles; especially in *S. antillense*, the terminal portion bearing this brush is distinctly marked off from the joint. The plate-shaped sympod contains muscles to the rami, two to the endopod, and at least one to the exopod. The two pleopoda of this pair touch each other at their base; they are covered by the first pair. In both sexes the pleopoda of the fourth pair (Pl. XX. fig. 2*k*) are similar as to size and structure; each has a short, broad sympod and a two-jointed exopod, which is slightly longer and somewhat broader than the unjointed endopod, and adorned with plumose setæ along the distal part of the outer margin; both rami are lamellar and both seem to be respiratory. The fifth pair (Pl. XX. fig. 2*l*) has no discernible sympod and only one ramus, which is large, unjointed, but otherwise shaped and adorned with setæ like the exopod of the preceding pair, and accordingly it is in all probability the exopod itself.

Uropoda consist of an unjointed sympod and two unjointed nearly styliiform rami; the exopod is as long as or longer than the sympod, nearly as long as or somewhat shorter than the endopod.

III. Comparison between the Genera *Stenetrium* and *Asellus*.

Pl. 39 in Sars's work is filled with figures of *Asellus aquaticus* L. I can therefore refer to his good drawings, and give only a new figure of the second male pleopod.

The essential differences between *Asellus* Geoff. and *Stenetrium* Hasw. are found in the antennæ, the maxillipeds of the adult female, and some of the pleopoda. The peduncle of the antennæ shows the same number of joints in both genera, but in *Asellus* the exopod from the third joint is wanting. In *Asellus* the basal joint of each maxilliped possesses in the ovigerous female a rather large plate, bearing a number of bristles at the end and directed

backwards; it has been mentioned and well drawn by Sars; its function is certainly to produce a current in the water of the marsupium.

The pleopoda show, however, some more interesting features. As in *Stenetrium*, the three posterior pairs in the male do not differ from those in the female; the very large two-jointed exopods cover, as in *Stenetrium*, not only the small respiratory endopods but almost the whole lower surface of the abdomen, and are freely exposed with the exception of a rather small basal portion. The fourth and fifth pairs are essentially alike, both consisting of a short sympod and two rami, viz. a two-jointed exopod, somewhat larger than the unjointed endopod; consequently we have here a well-marked difference in the fifth pair between *Stenetrium* and *Asellus*, as in the former genus the exopod—according to my interpretation above—is unjointed and the endopod wanting. In the female the pleopoda of the first pair are not fused as in *Stenetrium*, but independent and originate rather distant from each other; each pleopod consists of a nearly rudimentary sympod and a moderately large circular plate distally edged with plumose setæ. In the male each appendage of the first pair consists, as in *Stenetrium*, of a short sympod and a much longer suboval, movable ramus; but while in the latter genus the two sympods are completely fused, they are free in *Asellus*, but yet furnished with some hooks* along their inner margin, so that they can be coupled together nearly as the second joint of the maxillipeds. The second pleopoda in the male are interesting; the distal half of the left sympod with its rami is shown from below in Pl. XXI. fig. 3. The sympod is shortly oval, with both rami proceeding from its end and containing strong muscles for their movement. The exopod is oblong, nearly lamellar, only a little shorter than the endopod, two-jointed; the distal joint is somewhat larger than the basal one, obliquely oval, with marginal setæ and containing a good-sized muscle. The endopod consists of two movable joints; the proximal joint is short, but produced into a long, slender, curved process, turning inwards and forwards along the inner margin of the sympod; it contains a small muscle to the second joint. This is obliquely oval, its distal end rather rounded, but near the end a few minute teeth and irregular incisions and depressions are seen; the joint is besides inflated, and the major portion of its interior is occupied by a large pear-shaped sac, which opens at a short distance from the end of the joint; the wall of this sac is well chitinated. Having removed by dissection the major part of the wall of the joint itself, I was able to examine the wall of the inner sac. In the female second pleopoda are wanting.

Before attempting to decide as to the systematic importance of the differences between *Stenetrium* and *Asellus*, it may

* Each hook is a very thick and rather short spine, the end of which is broadly rounded, curved very slightly upwards, and the upper surface of its terminal portion is set with from seven to ten tiny, sharp, oblong teeth.

be appropriate to discuss the structure of the other Asellota, especially their pleopoda. It may be added that, according to descriptions given by S. I. Smith and A. S. Packard, the two genera *Mancasellus* Harg. and *Cœcidothea* Pack. are closely allied to *Asellus* in the structure of antennæ and pleopoda, the essential difference being that the endopod of the second male pleopod has no process from the basal joint.

IV. *On the Structure of the Asellota, Asellus and Stenetrium excepted.*

Some years ago A. Dollfus described and figured (Bull. Mus. d'Hist. Natur. Paris, 1898, no. 1, p. 37, figs. 2 & 2 a) a very curious animal, *Stenasellus virei* Dollf.; unfortunately he had only one minute and mutilated specimen from fresh water in the Cévennes. He refers the genus to the Asellota. His description together with the two figures are certainly sufficient for the recognition of the species, but not for deciding the question of the relationship of the genus. The uropods are as in the Asellota, and the four thoracic legs figured are, so far as can be seen, not very different from those in *Ianira*; but the animal differs from all Asellota in two features. The author says: "Cephalon intime-ment uni au premier segment pereial," which is not the case in any form of the Asellota hitherto known. The other feature is in the structure of the abdomen. Dollfus writes: "Pleon à trois premier segments très développés"; this agrees well with his figures, which show the abdomen as consisting of an oblong "pleotelson" and three segments; these latter are slightly narrower than, and their sum at least half as long as, the posterior undivided portion. But this abdomen differs much from that met with in any of the Asellota or any other group of Isopoda. In Dollfus's description we find as to the pleopoda only the statement that they are "narrow," and they are nearly invisible in his figures; besides, he does not mention the mouth-parts. Judging from all these circumstances I thought that *Stenasellus* could not be referred to the Asellota, and in the manuscript despatched to London in October I added some further critical remarks. But at the end of November Dr. Armand Viré, the ardent explorer of French caves, most kindly presented me with three specimens of *Stenasellus virei* captured in August 1904. An examination of these specimens showed that the abdomen has only two free segments in front of the large "pleotelson," and that the animal, in spite of some differences, is rather allied to *Asellus* in the structure of the mouth-parts and the pleopoda. I communicated my conclusions to Dr. Viré, who allowed me to make the necessary corrections in the proof, for which I beg him to accept my sincere thanks. I will therefore state that *Stenasellus* differs from other Asellota in having the head fused with the first thoracic segment, in having the two anterior abdominal segments well developed, while these are rudimentary in the Asellota (for instance in *Stenetrium*), and in a few other points. It must, in my opinion, be established

as a subfamily of the Asellidæ, but I will leave to my friends Dr. Armand Viré and Mr. Adrien Dollfus the further examination of the structure of this most interesting type.

Having thus discarded *Stenasellus*, and omitting *Asellus* (*Mancasellus*, *Cocidothea*) and *Stenetrium*, we shall now consider the remaining portion of Asellota, which comprises, I think, about thirty genera, twenty of which are found in Norway. Sars divides all Asellota into five equivalent families: Asellidæ, Ianiridæ, Munnidæ, Desmosomidæ, and Munnopsidæ. A perusal of Sars's account and of Beddard's 'Challenger' work will show that the genera which have been—or must be—referred to the four latter families present great differences in the shape of the body, in length and shape of the thoracic legs and their coating of spines or setæ, in the degree of development of the uropoda and similar features, but of more essential differences between these four families scarcely one is to be found. The peduncle of the antennæ is six-jointed; the exopod is sometimes rather large, sometimes rudimentary or absent. In the shape of the mandibles the differences between the genera decidedly allied to each other, and by Sars referred to his Munnopsidæ, are considerably larger than those which can be pointed out between the families. The other mouth-parts present no difference worth mention. The thoracic legs show frequently excellent generic characters, but the differences are so gradually developed that they are valueless as distinguishing characters between the families. I will refer the reader to the good figures given by Sars of the posterior pairs of legs and their development as natatory organs in *Echinopleura*, *Desmosoma*, *Pseudarachna*, and *Munnopsis*. The two former genera are referred to Desmosomatidæ, the two latter to Munnopsidæ; but the development of the legs as natatory organs is gradual, and the difference between these legs in *Pseudarachna* (with their seventh joint long) and *Munnopsis* (with seventh joint wanting) of the same family is conspicuously larger than between *Pseudarachna* and *Desmosoma*, which are referred to different families. The differences in the uropoda are only of generic value.—The pleopoda show great uniformity in the genera and families, but must be treated more in detail.

In the females of the four families recognised by Sars, the lower side of the abdomen, a more or less broad margin excepted, and the three posterior pairs of pleopoda are covered by a more or less vaulted operculum which does not show any suture; it is the first pair of pleopoda. The second pair is wanting. The third pair has always both rami; the exopod is sometimes small and unjointed, sometimes larger and two-jointed, in most cases it is situated along the margin of the endopod, but sometimes it overlaps a smaller or larger portion of this plate; furthermore, the difference in size between endopod and exopod is always at least considerably smaller than in *Asellus* or *Stenetrium*, and the two exopods do not constitute together a kind of operculum as in the two last-named genera. The fourth pair of pleopoda possesses,

at least generally, perhaps always, both rami, while the fifth pair has never more than one ramus, in all probability the exopod. In the males of the same four "families" the two anterior pairs of pleopoda constitute together a kind of large operculum, which consists of three separate plates coupled together; generally this operculum covers completely the three posterior pairs of pleopoda, but in an undescribed form—rather similar to *Ianira*—from the Southern Atlantic it reaches beyond the hind margin of these pairs, but laterally the major portion of the exopod of the third pair is left uncovered; it may be added that this exopod is longer but narrower than the corresponding endopod, and does not cover half of its area. The central plate of the operculum (Pl. XXI. figs. 4 & 5) is long, of various breadth, with the lateral margins more or less concave; it has a conspicuous suture along the middle, and is more or less cleft at the end; each half consists of the same parts as in *Stenetrium*, viz., an unjointed sympod (*s.*) and an unjointed ramus (*r.*). The two sympods are very long and coalesced with their inner margins; each of them has the posterior lateral angle produced so that a triangular more or less deep incision is seen between their distal parts. The ramus mentioned is attached to the oblique or sinuate posterior margin of this produced portion, often, as in *Ianira*, rather well marked off from it, sometimes, as in *Eurycope gigantea* G. O. S., fused with it so completely that a limit between them can be traced only at their distal end. The rami are not coalesced with each other, but are at most united by membrane in their proximal part. Each lateral part of the operculum consists of a large plate with the outer margin convex, the inner nearly straight or somewhat concave: this plate is the distal joint of the sympod, which has the two movable rami attached to the distal part of the inner margin, and contains muscles for their movement; in *Ianira* I found, besides, a very short part which, I think, must be a proximal joint of the sympod. The endopod is rather slender, strongly geniculate, typically two-jointed; the basal joint is directed forwards, contains a muscle to the second joint, and at least sometimes, as in *Eurycope gigantea* G. O. S. (Pl. XXI. fig. 6, *b.*) it is divided again into two joints. The distal joint is directed backwards, curved and always produced into a point; often it is long, with the distal part extremely slender; in *Munnopsis typica* M. Sars it is even more than half as long as the whole animal, reaching far beyond the abdomen, and this uncovered portion is setiform. The joint contains a pear-shaped or very oblong cavity (Pl. XXI. fig. 6, *c.*), which continues into a narrow duct (*d.*) opening at the end of the joint. The exopod (*ex.*) is very short, two-jointed; the distal joint is shaped as a hook, the function of which is to couple the appendage with the sympod of the first pair of pleopoda; on the upper (posterior) side of the sympod an impression and a ridge is formed for the reception of this hook. The three posterior pairs of pleopoda in the male are exactly as in the female.

Before concluding this account an apparent exception may be mentioned. In Sars's work pl. 50 is filled with drawings of *Nannoniscus oblongus* G. O. S. The author figures two animals which he believes are female and male of the same species. On the figure representing the male abdomen from below is seen a large undivided operculum. In the text he says (p. 120): "It is a very remarkable fact, that the operculum in neither of the two specimens examined showed any trace of the usual transformation, though the male character of the specimens otherwise could easily be demonstrated, both by the greatly projecting sexual prominence, and by the presence of well-developed testes shining distinctly through the integuments in their usual place. In the Caspian species, on the other hand (of which as yet only a solitary male specimen is known), the sexual characters were quite normally displayed." But such differences between the males of species belonging to the same genus do not exist; the second pair of pleopoda with its complex organisation for copulation is not wanting in the male of one species, and highly developed in the male of another species of the same genus. What Sars considers to be the male of *N. oblongus* is in reality a female of another species: I cannot account for the nature of the structure interpreted by him as testes, but the large spine in front of the operculum has nothing to do with the "sexual prominences" of the seventh thoracic segment in a male. I may add that I am very well acquainted with the genus *Nannoniscus*; chiefly from the 'Ingolf' our Museum possesses examples of about ten species, all with the globular or ovate organ at the end of the antennulæ also found in the two species described by Sars as *N. oblongus* G. O. S.

V. *Morphological Interpretation of the Pleopoda in Asellota.*

In the three preceding sections the pleopoda and their parts are mentioned as if the names applied had been generally used or accepted by carcinologists, but it is far from being so. Some of the interpretations are new, others not generally accepted; for these reasons it may be useful to give a comparative review of this subject.

I must admit that I have not looked through many of the descriptions of pleopoda scattered in the literature of the last fifty years or more in order to be able to point out that an author, in the description of a genus or a species, might have proposed one or another of my interpretations; but I am sure that the major part of them are either new or set forth in some of my earlier papers. In the account of the Crustacea in 'Dijmphna-Togtets zoologisk-botanisk Udbytte,' Kjöbenhavn, 1887*, I gave a detailed description (with figures) of *Eurycope gigantea* G. O. S.; on p. 202 I stated that the three parts of the male operculum are respectively the fused first pair and the endopods of the second

* I had received and distributed separate copies of my paper in this work by the middle of July 1886.

pair of pleopoda; the latter interpretation is not correct, each lateral plate being not the endopod but the sympod, bearing its two rami; furthermore, I described the three-jointed copulatory organ and the two-jointed hook, but did not perceive that they are the rami of this appendage. In 'Isopoden, Cumaceen und Stomatopoden der Plankton-Expedition,' 1895, I wrote (p. 6):—"Ich habe *Ianira* Leach, *Iolanthe* Bedd., *Iaera* Leach, *Munna* Kr., *Pleurogonium* G. O. S., *Macrostylis* G. O. S., *Munnopsis* M. Sars und *Eurycope* G. O. S., welche Sars in seinen 3 Familien vertheilt, sammt *Asellus* Geoffr. und eine vermuthlich zu *Stenetrium* Hasw. gehörende westindische Form, untersucht. Alle die erstgenannten 8 Gattungen weichen nun gründlich in dem Bau der Pleopoden von den zwei letztgenannten ab, die sich ziemlich nahestehen. Bei den ersten 8 Gattungen findet man folgenden Bau: Bei dem Männchen bildet das 1. und 2. Paar Pleopoden zusammen einen grossen, festen, aus drei Theilen bestehenden Deckel, der vollständig die drei folgenden, zum Athmen eingerichteten Paare bedeckt (der Deckel entsteht dadurch, dass das 1. Paar zu einer schmäleren Mittelplatte zusammen gewachsen ist, während das 2. Paar die breiten, mit Paarungsorganen versehenen Seitenplatten bildet); bei dem Weibchen bildet das 1. Paar einen mächtigen, ungetheilten Deckel für das 3. bis 5. Paar, während das 2. Paar gänzlich fehlt. Bei *Asellus* und *Stenetrium* wird der Deckel bei beiden Geschlechtern von ganz andern Elementen gebildet, nämlich von den Aussenästen der 3. Paare von Pleopoden; diese Aussenäste sind nämlich zu mächtigen Platten entwickelt, die in der Mittellinie zusammenstossen und vollständig den kleinen Innenast und die beiden folgenden Pleopodenpaare decken; bei dem Männchen befinden sich vor diesem Deckel 2 kleine, freie Pleopodenpaare, das 2. Paar mit den Paarungsorganen; bei dem Weibchen fehlt das 2. Paar, während sich das 1. Paar in Form von 2 kleinen, freien Platten vorfindet." The last sentence in this quotation is erroneous as to *Stenetrium*; otherwise the whole passage is correct, so far as it goes.—In his recent work on the Isopoda G. O. Sars says (p. 96):—"A closer examination of this compound operculum [in the males of most Asellota] will, however, soon show, that the suggestion at first put forward by Dr. Hansen is quite correct." He then gives an abstract of my results, already quoted here, and continues: "By such an explanation, indeed, more uniformity is obtained, as to the number of appendages of the metasome, which, in fact, is the very same in all Asellota, viz., 4 pairs in the female, and 5 pairs in the male, the additional pair constituting the copulative appendages." Sars is thus inclined to follow me as to these questions, but on the plates (39 and 40) with figures of *Asellus* and *Ianira* he names the third pair of pleopoda *plp*², the fourth pair *plp*³; he goes even so far that on the plates (43 and 44) with *Iaera* and *Munna boeckii* he marks the third pair *plp*¹, the fourth pair *plp*², &c., but this is inconsistent and rather confusing.

It cannot be denied that in all Asellota we have five pairs of pleopoda in the male, but only four pairs in the female. Further-

more, the third pair in the male is shaped exactly as that pair which in the female follows the operculum; the penultimate pair in the male is exactly like the penultimate in the female, but differs from the preceding and from the last pair. We must therefore conclude that the three posterior pairs in both sexes are homologous. That the undivided operculum found in all genera, *Asellus* excepted, in the female is homologous with the first pair in the male, must be concluded from the fact that in all these genera the two appendages constituting this pair in the male have their sympods coalesced or, as in *Stenetrium*, completely fused. The second pair, which in the male bears the copulatory organs, is therefore wanting in the female.

Next, the interpretation of the parts constituting the two anterior pairs in the male must be considered. *Asellus* presents the best starting-point. That the two joints of the first pair in this animal are respectively the distal joint of the sympod—its two proximal joints having disappeared—and one of the rami must, I think, be admitted, and is easily seen from comparison with *Cirolana*, *Ega*, &c., but it is impossible to decide whether the distal joint, the ramus preserved, is the endopod or the exopod. The second pair in *Asellus* is easy to interpret: each appendage consists of the sympod with the two two-jointed rami proceeding from its distal end; no other interpretation is possible, but the result is that it is the endopod itself which is transformed as a kind of copulatory organ, with a cavity in the interior of its distal joint.

Let us, then, look at the first pair of the male in other Asellota. In *Stenetrium* (Pl. XX. fig. 2g) the sympods are fused, and the plate thus formed bears two unjointed rami, but, as in *Asellus*, it is impossible to decide whether they are the endopods or the exopods. Comparing this structure with that in *Ianira* (Pl. XXI. fig. 5), and especially in the undescribed genus (Pl. XXI. fig. 4), it must be admitted that the distal pair of lobes marked off by oblique lines from the long proximal plate must be the rami found in *Asellus* and *Stenetrium*.

Finally, we must consider the second pair of the male in *Stenetrium* and other Asellota. As in *Asellus*, we find a sympod with two rami, the essential difference being that these rami proceed not from the end but from the inner margin of the sympod. The most distal ramus, which in all genera, *Stenetrium* excepted, is shaped as and performs the function of a hook, is therefore the reduced exopod; as in *Asellus* it is always two-jointed, *Stenetrium* excepted, but even in a species of this genus a vestige of a division into two joints is discernible. The copulatory organ is the endopod; as in *Asellus* it is two-jointed—in *Eurycope* I found the basal joint divided again into two joints (Pl. XXI. fig. 6)—and the distal joint has an internal cavity, *Stenetrium* excepted. (Beddard, in his 'Challenger' Isopoda, has already correctly interpreted the rami as endopod and exopod in *Stenetrium* and *Ischnosoma*.) It can be added that we have now found the key to the interpretation of the endopod of the second pair of pleopoda

in the male of other Isopoda. In *Idothea*, *Sphaeroma*, *Cirolana*, *Cymothoa*, &c., this endopod is generally described as an undivided plate with an "appendix masculina" articulated at its inner margin: *this plate is the first, the "appendix" the second joint of the endopod.* This endopod is therefore two-jointed in all Isopoda, Epicaridea and Gnathiidae excepted; but in most forms only the second joint is transformed, the first being large and lamellar like that of the first or the third pair, while in Asellota and Oniscidae both joints are narrow.

VI. *The Classification of the Asellota.*

The tribe or suborder Asellota is very sharply defined from all other Isopoda, but its subdivision into families is a matter of considerable difficulty. As already stated, G. O. Sars in 1897 divided the Asellota into five families, but four of these are far from distinct from each other; moreover, other objections can be raised. His family Desmosomatidae is in reality a rather mixed company: such genera as *Macrostylis* and *Ischnosoma* differ strongly from each other in most features; *Nannoniscus* and especially *Ischnosoma* are far from being closely related to *Desmosoma*, &c. I have, for the rest, already, on p. 308, pointed out several difficulties as to these four families; it may be added that from the 'Ingolf' we have several new forms which differ rather or very considerably from the genera of Sars, so that an attempt at arranging them within his families will aggravate the state of things. When nature has not worked out groups well-defined from each other we can of course subdivide a tribe or suborder into families, founding them on some points in the general aspect of the animals, but their number and limitation must then be a matter of personal opinion, and many other authors will propose the establishment of other or of new families not better than those first erected. It is, in my opinion, *to be preferred to keep a very large group of genera in the same family, a large number of species in the same genus, than to subdivide respectively the family or genus into families and genera with new names, when sharp lines of distinction are not to be found in nature.*

It is well-known that differences in the structure of the abdominal appendages are among the most important characters for dividing the order Isopoda into tribes or main-families. That considerable importance must be ascribed to the above-named differences in the structure of the pleopoda in *Asellus*, *Stenetrium*, and other Asellota, will probably be admitted, these differences being much sharper than those met with in any other external organ. In the Plankton paper I wrote in 1895 the long passage quoted above on differences in the pleopoda between *Asellus* and *Stenetrium* on one side, and several other genera of Asellota on the other, and continued:—"Es ist anzunehmen, dass alle existirenden Gattungen in die eine oder die andere dieser zwei nach äusserst scharfen Kennzeichen getrennten Gruppen eingefügt werden können, welche also die 2 Familien bilden, in welche die

Asellota am besten getheilt werden können." But two years later Sars added very much to our knowledge of numerous genera of *Asellota*; furthermore, in 1895 I saw a very large number of undescribed forms—among which several new genera—unknown to me, and received and studied more closely many examples of *Stenetrium*. The question as to the classification of the *Asellota* can therefore now be reconsidered on a broader base.

Putting *Stenetrium* aside, it will probably be admitted that the differences in the pleopoda between *Asellus* (with *Mancasellus* and *Cæcidothea*) and other *Asellota* would justify the division of the *Asellota* into two families. But the structure in *Stenetrium* gives rise to considerable difficulty. Both in *Stenetrium* and *Asellus* the two anterior pairs of pleopoda in the male and the first pair in the female are quite small, and overlap only a small proximal portion of the following pair, the exopods of which are very large and constitute a complete covering for the respiratory lamellæ; furthermore, in the second pair of the male the end of the endopod is blunt and the exopod not developed as a hook for coupling together the two anterior pairs.

In all other *Asellota* the first pair in the female is very large and covers the following pairs completely; in the male the two anterior pairs constitute together a large operculum formed by coupling of three plates, which cover the following pairs in their whole length and, with a single exception, also in their whole breadth; the exopods of the third pair are, therefore, generally invisible, in the instance alluded to partly visible from below at the side of the operculum, but in this animal (Plate XXI. fig. 5) they are yet of moderate size, and their inner margin rather distant from the mesial line; furthermore, in the second pair of the male the end of the endopod is acute, the exopod hook-shaped and adapted for coupling. On the other hand, *Stenetrium* differs from *Asellus* and agrees rather well with other *Asellota* in some particulars, viz.: in the male the sympods of the first pair of pleopoda are fused with each other, and the rami of the second pair are attached to the inner margin of the sympod; in the female the pleopoda of the first pair are fused with each other, in both sexes the last pair has only one ramus. The genus is distinguished among all other *Asellota* by the curious feature that the endopod of the second pair in the male is without an internal cavity in its distal joint.

That *Stenetrium* differs less than *Asellus* from the other *Asellota* is thus easily seen, and the question arises as to the systematic importance of the differences and similarities. Ought *Stenetrium* to be placed together with *Asellus* or established in a family of its own? Considering all particulars, I am now inclined to prefer the latter alternative. The *Asellota* will therefore be divided into three families—*Asellidæ*, *Stenetriidæ*, n. fam., and *Parasellidæ*, n. fam.

The first-named family comprises the genera *Asellus* Geoffr., *Mancasellus* Harg., and *Cæcidothea* Pack.; the second family only its single genus; the *Parasellidæ* all the other genera of *Asellota*.

Diagnoses of these three families may now be given :—

A. ASELLIDÆ.

First pair of pleopoda in the male small, the sympods free, very short, together much broader than long, with coupling-hooks along their inner margins; rami (only a single pair) movable, much longer than the sympods.—Appendages of same pair in the female attached rather far from each other, each consisting of a minute sympod and a circular ramus of moderate size and edged with setæ.—In both sexes this pair overlaps only a small basal portion of third pair.

Second pair in the male small, situated above and not coupled with the first pair. Rami attached to the distal margin of the sympod; endopod not geniculate, its distal joint inflated, containing a large cavity and its end obtuse; exopod nearly as long as the endopod, its distal joint movable, lamellar, with marginal setæ.

Third pair in both sexes has the exopods very large, touching each other along the mesial line, and constituting a complete covering for the endopod and the following pairs; this operculum is freely exposed except at the base.

Fifth pair with endopod and exopod well developed.

B. STENETRIIDÆ.

First pair of pleopoda in the male small, the sympods completely fused with each other, very short, together much broader than long; rami movable, much longer than the sympods.—Appendages of same pair in the female completely fused, constituting a small oblong operculum without suture or marginal setæ.—In both sexes this pair overlaps only a small basal portion of third pair.

Second pair in the male small, situated above and not coupled with the first pair. Rami attached to the distal part of the inner margin of the sympod; endopod strongly geniculate, its distal joint rather narrow, without internal cavity, and with the end obtuse; exopod very short, several times shorter than the endopod, unjointed (at most with a vestige of a division into two joints), narrow, scarcely hook-shaped, at most with a single seta.

Third pair in both sexes has the exopods very large, touching each other along the mesial line, and constituting a complete covering for the endopod and the following pairs; this operculum is freely exposed except at the base.

Fifth pair with only one ramus, in all probability the exopod.

C. PARASELLIDÆ.

First pair of pleopoda in the male large; the sympods coalesced with each other, together longer than broad, with the lateral margins concave; rami immovable, much shorter than the sympods.—Appendages of same pair in the female completely fused, constituting a very large operculum without suture or marginal setæ.—In the female this pair covers completely the following pairs; in the male it reaches beyond the distal margin of the

following pairs, the lateral portions of which are generally completely covered by the second pair.

Second pair in the male large; the major portion of the sympods situated outside and coupled with the first pair. Rami attached to the distal half of the inner margin of the sympod; endopod strongly geniculate, its distal joint slender, containing an internal cavity and distally produced into a point; exopod very short, many times shorter than the endopod, two-jointed, narrow, hook-shaped, without setæ.

Third pair in both sexes has the exopods of moderate size, not touching each other in the mesial line, generally completely covered by the first pair (in the female) or by the two anterior pairs (in the male); only in the male of a single form their exterior portion is uncovered.

Fifth pair with only one ramus, in all probability the exopod.

VII. *The Species of the Genus Stenetrium.*

The genus was established in 1881 by A. Haswell on two species, *S. armatum* Hasw. and *S. inerme* Hasw. The first-named must be regarded as the type for the genus; besides it will be proved below that according to Haswell's description and figures of *S. inerme* this species, in all probability, cannot be referred to the same genus.

Though I have examined only one of the five species referred to *Stenetrium* by previous authors, I have deemed it useful to incorporate them in the analytical key, and to describe them as well as possible, applying some of the characters found in the descriptions of the authors, and adding others drawn from their figures, hoping that these are tolerably correct as to the details in question. It has not been my intention to mention features showing differences of slight or no value for the determination of the species.

Conspectus of the Species.*

- A. Basal joint of antennulæ, seen from above, anteriorly at the outer side produced into an oblong acute process, or at least (in *S. haswellii*) with a conspicuous tooth marked off from the oblique front margin by an indentation.
 - a. First thoracic legs with the upper distal corner of fifth joint † not produced into a process.
 - α. Hand of first legs in both sexes conspicuously more than $\frac{3}{4}$ as long as deep..... 1. *S. armatum* Hasw.
 - β. Hand of first legs in the male (?) less than $\frac{3}{4}$ as long as deep (only one specimen known) 2. *S. fractum* Chilton.

* In the key *S. inerme* Haswell is omitted; this species is mentioned below after the descriptions of the other forms.

† First joint of these legs is fused with the thoracic segment; the following long joint, which apparently is the first, is here and in the sequel regarded as the second, according to the morphological interpretation of these legs; in the six other pairs of thoracic legs the first short joint is, as in all Asellota, not fused with the thorax but movable.

- b. First thoracic legs with the upper distal corner of fifth joint produced into a long process.
- a. Basal joint of antennulæ, seen from above, anteriorly at the outer side produced into a long process reaching considerably beyond the distal margin of second joint. 3. *S. mediterraneum*, sp. n.
- β. Basal joint of antennulæ, seen from above, without any real process, but at the outer distal angle with a conspicuous sharp tooth, well marked off from the oblique front margin by an indentation, and far from reaching to the distal end of second joint 4. *S. haswellii* Bedd.
- B. Basal joint of antennulæ, seen from above, with the exterior half of the distal margin transverse, outer angle at most rectangular and acute, but without process or tooth.
- a. Lateral corner of the head, seen from above, produced into an acute process. Eyes rather large, oblong.
- α. Abdominal shield on each lateral margin with about five sharp teeth. First thoracic legs with the upper distal angle of fifth joint produced into a long process... 5. *S. serratum*, sp. n.
- β. Abdominal shield on each lateral margin with only the tooth at the notch. First thoracic legs with the upper distal angle of fifth joint rectangular, without process.
- † In the male the lower margin of the hand has its proximal half concave, and at the distal end a low broad process with three or four teeth nearly equal in size placed in a convex line. In the female the angle between the palmar and the lower margin of the hand measures about 110° ; the hand is a little more than $\frac{3}{2}$ as long as deep 6. *S. occidentale*, sp. n.
- †† In the male the lower margin of the hand has its proximal half convex, and at the distal end two processes separated by a rather deep incision; each process terminates in two teeth. In the female the angle between the palmar and the lower margin of the hand measures about 125° ; the hand is twice as long as deep* 7. *S. stebbingii*, H. Richardson.
- ††† In the male the lower margin of the hand has its proximal half convex, and at the distal end a narrow, moderately long process, with the end bifurcate, and sometimes besides a feeble tooth on its proximal margin. In the female the angle between the palmar and the lower margin of the hand measures less than 100° , and the hand is a little more than $\frac{3}{2}$ as long as deep ... 8. *S. antillense*, sp. n.
- b. Lateral corner of the head, seen from above, without any process. Eyes small, sub-circular 9. *S. siamense*, sp. n.

* All these characters have been derived from the figures given by Miss Harriet Richardson.

1. *STENETRIUM ARMATUM* Hasw. Ovigerous female (and adult male, after Haswell*). (Plate XIX. figs. 1 a-1 d.)
1881. *Stenetrium armatum* Haswell, Proc. Linn. Soc. New South Wales, vol. v. p. 479, pl. xix. fig. 1 [*teste* Haswell].
1882. *Stenetrium armatum* Haswell, Catal. Austral. Stalk- and Sessile-eyed Crust. p. 308.
1884. *Stenetrium armatum* Haswell, Proc. Linn. Soc. New South Wales, vol. ix. pp. 1009-1010, pl. li. figs. 1-12 [*teste* Zool. Rec. and Beddard].

Head has its upper surface—the frontal plate excluded—more than twice as broad as long; the lateral part is expanded and flattened, the anterior corner produced into a rather long acute process with a minute tooth on the outer margin; the front margin outside the base of each antennula produced into a rather large, triangular, very acute process. Eyes semilunar, long, oblique, with the posterior outer margin rather close to the lateral margin of the head.

Antennulæ have the second joint of the peduncle slightly shorter than the third and rather thick; flagellum of the female is much shorter than the peduncle, with about seven joints.

Antennæ have the basal joint, seen from above, anteriorly at the outer side produced into a rather long acute process reaching slightly beyond the end of the second joint and with a small saw-tooth on the outer edge.

First thoracic legs.—In the female the distal half of the upper part of third joint is expanded, compressed, and produced into a long curved process; nearly the whole upper side of fourth joint is expanded, compressed, and produced into a long process directed forwards; fifth joint with upper distal angle subrectangular and without process, lower angle rounded. The hand not fully twice as long as deep; upper margin rather convex, lower margin at least as long as the depth, straight, with many long setæ; the angle between the lower margin and the palmar edge measures nearly 110° , is somewhat rounded, with a long strong spine; palmar edge nearly straight, with several thick setæ serrated along their upper margin. Seventh joint with the short claw claw-shaped; the lower margin of this joint armed with a close row of short spines with a few saw-teeth along the lower margin.—In the male third, fourth, and fifth joints in all probability as in the female, the hand is, according to Haswell's figure, oblong as in the female, but it has two deep incisions in the palmar edge, and the process between them is bidentate; the "claw" reaches a little beyond the palm.

Abdominal shield is somewhat broader than long. Each lateral margin has about four obscure saw-teeth, besides the usual rather long tooth at the notch. The posterior margin is strongly convex and a little sinuate.

* Mr. R. I. Pocock has kindly traced for me the figures given by Haswell in his first paper.

Uropoda considerably less than half as long as the abdominal shield; the endopod somewhat longer than the exopod.

Length of a female with marsupium 5.2 mm.; Haswell gives the length $\frac{1}{2}$ inch.

Occurrence. According to Haswell this species has been captured on the south-eastern coast of Australia: Port Jackson, Port Stephens, Griffiths' Point (Victoria). Of a specimen in the British Museum (from Griffiths' Point) I have figured the abdomen from below; two specimens (from Port Jackson), belonging to the Museum in Dundee, have kindly been forwarded me, and my three other figures of this species were taken from one of these specimens, an almost full-grown female.

Remarks. This species is easily distinguished from all following forms, *S. fractum* Chilt. excepted, by the shape of the head and basal joint of antennæ, together with the joints of first thoracic legs. Its differences from *S. fractum* are mentioned in the following description of this species.

2. STENETRIUM FRACTUM Chilton.

1887. *Stenetrium fractum* Chilton, Transact. and Proc. New Zealand Institute, 1883, vol. xvi. p. 249, pl. xviii. figs. 3 a-f.

Chilton described and figured a single specimen, the body of which had been "much crushed." Unfortunately, he says nothing as to the shape of the head; but judging from the antennæ and the shape of abdomen, I think that the species must be related to *S. armatum* Hasw. Most of the characters given below have been selected among his statements, other characters have been derived from his figures*.

Antennulæ.—"First joint of the peduncle large, as broad as long; second equal in length to the first, but more slender; third rather longer than the second, ... flagellum about half as long again as the third joint of peduncle, consisting of about five joints"

Antennæ have the basal joint "produced acutely at its extero-distal angle"; according to fig. 3 b the process does not reach the end of second joint.

First thoracic legs.—Fourth joint much expanded above and its upper corner produced into a rather long triangular process, which seems to be a little shorter and thicker than in *S. armatum*. Fifth joint shaped about as in the last-named species. Hand very deep, about $\frac{4}{3}$ as long as deep, thus proportionately considerably deeper than in the female of *S. armatum*; upper margin as in that species; lower margin seems to be a little convex; the angle between this margin and the palmar edge almost 120°; palmar margin straight, armed with thick setæ pectinate along their upper margin and a spine of very moderate length at the lower angle. Seventh joint and claw as in the female of *S. armatum*.

* My friend Dr. W. T. Calman has kindly sent me a copy of Chilton's description and tracings of his figures.

Abdominal shield.—Lateral margins “irregularly serrate,” “ending posteriorly in a sharp point followed by a small concave indentation”; the posterior margin almost as in *S. mediterraneum*; its middle portion is somewhat produced, so that a rather low rounded lobe or protuberance is formed, and almost each lateral half of the margin is somewhat concave.

Uropoda, according to fig. 3*f*, much less than half as long as the abdominal shield; endopod considerably longer than exopod.

Length “about $\frac{1}{8}$ inch.”

Occurrence. Lyttelton Harbour, New Zealand.

Remarks. Chilton supposes that his specimen was a female; judging from the extreme depth of the prehensile hand, I think it was a male. It is distinguished from *S. armatum* Hasw. by a shorter process from the basal joint of the antennæ, by the serration of the lateral margins and the shape of the posterior margin of abdomen, and by the extreme depth of the prehensile hand in the sex described.

3. *STENETRIUM MEDITERRANEUM*, sp. n. Adult male and ovigerous female. (Plate XIX. figs. 2*a*–2*h*.)

Head has its upper surface—the frontal plate excluded—not fully twice as broad as long; the lateral part is strongly expanded and flattened, the lateral corner produced into a rather long acute process without distinct tooth on the outer margin; the front margin outside the base of each antennula produced into a moderately small, triangular, acute process. Eyes long, oblique, rather narrow but broader behind than in front; their outer margin is strongly convex, the inner concave; posterior part of their outer margin rather close to the lateral margin of the head.

Antennulæ have the second joint of the peduncle moderately slender and a little shorter than the third; flagellum in the male somewhat shorter than the peduncle, with eleven or twelve joints, in the female considerably shorter than the peduncle, with about nine joints.

Antennæ have the basal joint, seen from above, at the outer side produced into a long, rather narrow, acute process reaching far beyond the distal end of second joint; external margin of the process with a couple of long setæ inserted at a minute saw-tooth in front of the middle.

First thoracic legs rather similar in both sexes, of moderate length. Third, fourth, and fifth joints with the upper part strongly expanded, compressed; the expansion begins rather near their base, and is in front produced into a triangular acute process, which is rather broad and moderately long on third and fourth joints, somewhat longer and much narrower on the fifth. In the male the hand is somewhat less than twice as long as deep; upper margin somewhat convex, with a few shorter setæ; lower margin as long as the depth, straight, with numerous very long hairs; the angle between lower margin and palmar edge measures about 120°; palmar edge is a little sinuate, with a moderately large,

rounded tubercle below its middle and a couple of minute tubercles or denticles above the large tubercle; the edge is besides furnished with some robust setæ, increasing much in length downwards and pectinate along their upper margin; lower end of palmar edge armed with a strong long spine, the structure of which is shown in fig. 2e; seventh joint with its short claw claw-shaped, reaching slightly beyond the palmar edge, along its lower margin with fine setæ and a row of small strong spines adorned with a few saw-teeth on their lower margin.—In the female the hand is a little smaller and a little shorter in proportion to the depth than in the male, but it differs especially in the palmar edge, which is feebly convex and quite without tubercles; seventh joint and claw as in the male.

Abdominal shield a little broader than long. Each lateral margin with four or five minute spines placed at rather long intervals, and terminating in the usual triangular tooth at the conspicuous notch; behind this notch a minute indentation is observed. Posterior margin has its middle portion produced so that a rather low rounded lobe is formed, and almost each half of the margin is moderately concave.

Uropoda considerably more than half as long as the abdominal shield; exopod slightly longer than sympod, but considerably shorter than endopod.

Distal joint of the endopod of second male pleopoda unusually slender and not widened at or beyond the middle; a short terminal portion only half as broad as the remainder, with the end cut off transversely and without any brush.

Length of the largest male 5.5 mm., of an ovigerous female 6 mm.

Occurrence. Some specimens were taken by the author at Siracusa, Sicily, in depths from 12 to 25 fathoms; four specimens were secured by the Danish botanist, Dr. Børgesen, at Ajaccio, Corsica.

Remarks. This fine species is easily distinguished by the very long process on the basal joint of antennæ, by first thoracic legs in both sexes, and by the shape and armature of abdomen.—None of the forms mentioned in Carus's 'Prodromus Faunæ Mediterraneæ' can be referred to *Stenetrium*, and the present species seems to be new, though it is probably widely distributed in the western half of the Mediterranean.

4. STENETRIUM HASWELLII Bedd.

1886. *Stenetrium haswelli* Beddard, Proc. Zool. Soc. London, 1886, p. 103.

1886. *Stenetrium haswelli* Beddard, Isopoda ii. in 'Challenger' Rep. vol. xvii. p. 9, pl. iv. figs. 1-8.

The only specimen hitherto known is a male described and figured by Beddard. From his long description most of the characters given below have been selected; some of my statements have been derived from his figures, and from two sketches

kindly drawn for me from the type specimen in the British Museum (Natural History) by Dr. W. T. Calman.

Head.—The lateral part is exceedingly expanded and anteriorly produced into a very large, broad and long, triangular, acute process, reaching forward nearly as far as the front margin of second joint of the antennæ; the front margin outside the base of each antennula produced into a rather broad, moderately long, triangular acute process. Eyes long, very narrow, feebly curved, oblique but essentially transverse, with their posterior end rather far from the lateral margin of the head.

Antennulæ have the second joint of the peduncle rather slender and somewhat shorter than the third; flagellum very much longer than the peduncle, consisting of numerous joints.

Antennæ have the basal joint, seen from above, rather small, somewhat oblique; without any real process, but at the outer distal angle with a conspicuous sharp tooth, well-marked off from the oblique front margin by an indentation, and far from reaching to the distal angle of second joint.

First thoracic legs elongate, slender, but widening distally, with a large hand. Third joint long, with the distal part of the upper side considerably expanded and produced into a rather long, oblong-triangular process directed essentially forward; fourth and fifth joints each considerably shorter than the third, but the distal half of the upper side is more expanded and produced into an oblong-triangular acute process, which is long on the fourth, very long on the fifth joint. The hand is (according to Beddard's fig. 4) large and very deep, not fully $\frac{4}{3}$ as long as deep; upper margin is strongly convex and furnished with very long hairs on its distal half; lower margin is straight, with long hairs; the angle between lower margin and palmar edge measures about 100° , but is somewhat rounded; palmar edge a little shorter than the lower margin, straight, with a "row of serrate spines, below which a few fine slender hairs," and at its lower end a stout but moderately short spine. The "claw" of normal size and shape, with serrate spines along its lower edge.

Abdominal shield nearly as long as broad; according to sketches and notes by Dr. Calman, the lateral margin, though "a good deal chipped and broken," "is very finely serrated, at least in places," and terminates behind in a small tooth at the usual notch; posterior margin shaped almost as in *S. serratum*.

Uropoda, according to Beddard's figure, more than half as long as the abdominal shield; rami, according to his text, "subequal in size."

Distal joint of the endopod of second male pleopoda slender and not expanded at or beyond the middle, terminating in a small brush.

Length of the single male specimen 16 mm.

Occurrence. 'Challenger' "Station 320, off the Rio de la Plata, February 14, 1876; lat. $37^{\circ} 17'$ S., long. $53^{\circ} 52'$ W.; 600 fathoms."

Remarks. This deep-sea species is the largest form of the genus hitherto known; it is easily distinguished from all other species by the very large lateral processes of the head, the shape of the eyes, of the basal joint of antennæ, and of the first thoracic legs.

5. *STENETRIUM SERRATUM*, sp. n. Ovigerous female. (Plate XIX. figs. 3 a-3 d; Plate XX. fig. 1 a.)

Head has its upper surface (the frontal plate excluded) nearly twice as broad as long; the lateral part is somewhat expanded and flattened in front, and produced into a moderately large acute process; the front margin outside the base of each antennula produced into a rather large process, which is broad at the base, while its distal part is shaped as a narrow acute hook curved somewhat inward. Eyes large, oblong, very oblique, the outer margin extremely convex, the inner very concave; their posterior part overlaps the lateral margin of the head itself.

Antennulæ have the second joint of the peduncle moderately robust and somewhat shorter than the third; flagellum 9-jointed, as long as the sum of the two proximal joints of the peduncle.

Antennæ have the basal joint, seen from above, distally cut off transversely, its outer angle acute, but not produced into any process.

First thoracic legs rather short. Third joint distally widened but without process; fourth joint with the upper part nearly from the base strongly expanded, compressed and distally produced into a process of moderate length and breadth; fifth joint similarly expanded and distally produced into a long slender process. Hand a little more than twice as long as deep; upper margin rather feebly convex, with a few setæ; lower margin straight, only half as long as the upper, with numerous very long hairs; distal end as long as the lower margin; palmar edge very oblique, a little sinuate, furnished with six very stiff setæ, proportionately long and increasing in length downwards, pectinate along their upper margin, and at the end of the edge a moderately robust very long spine pectinate as the setæ; the angle between palmar edge and lower margin measures about 130° . Seventh joint with its claw claw-shaped, reaching a little beyond the lower end of the palmar edge; the joint is adorned below with serrated spines and fine curved setæ as in *S. mediterraneum*, but the spines are less numerous, only about ten.

Abdominal shield is somewhat broader than long; each lateral margin is adorned with five small nearly spiniform processes, increasing in size backwards and placed at regular intervals, the last of these processes being that at the usual notch. Posterior margin is rather evenly but moderately curved.

Uropoda wanting.

Length of the single adult female 6 mm.

Occurrence. West Indies: St. Thomas, one specimen (*Krebs*).

Remarks. This species is easily distinguished from *S. armatum*, *S. fractum*, and *S. mediterraneum* by the absence of a process

from the basal joint of antennæ. The processes from the front margin of the head are more produced and much more curved, the processes or teeth on the lateral margins of abdomen conspicuously longer than in any other species hitherto discovered.

6. *STENETRIUM OCCIDENTALE*, sp. n. Adult male and ovigerous female. (Plate XX. figs. 2 a-2 n.)

Head shaped as in *S. antillense* (Pl. XXI. fig. 1 b); its upper surface (the frontal plate excluded) is considerably less than twice as broad as long; the lateral part, seen from above, is feebly expanded and produced into a small acute process; the front margin outside the base of each antennula produced into a broad but rather low process, with the end obtuse. Eyes of moderate length, oblong, somewhat curved, very oblique and considerably removed from the lateral margin of the head.

Antennulæ with the second joint slightly longer than the third, moderately robust; flagellum in the male 9-jointed and as long as the sum of the two distal joints of peduncle, in the female still shorter, with four or five joints.

Antennæ have the basal joint distally cut off transversely, its outer angle without process and measuring about 90°.

First thoracic legs very different in adult specimens of the two sexes, but in immature males nearly as in adult females.—In the male they are rather long, robust; third joint is distally much expanded above and produced into a triangular process directed upwards; fourth joint expands above gradually from the base, forming a broad but rather low process, a portion of the inner surface of which is furnished with numerous exceedingly long hairs. Fifth joint has the upper margin very short, without any process, but it expands below, its lower margin is several times longer than the upper, and besides it is produced into a very long oblong-triangular process, the inner side and both margins of which are closely set with long or very long hairs; the upper margin of the process is straight nearly to the insertion of the hand, and the distance from this insertion to the end of the process is longer than the distance from the insertion to the base of the joint. The hand is very large, a little broader near the end than at the base, two and a half times longer than deep; upper margin strongly convex, lower margin rather concave from the base to the distal process, which occupies the major portion of the short palmar edge; this process is low, broad, its margin more or less convex and divided into three or four teeth; the lower major portion of the inner surface of the hand is closely set with very long hairs. Seventh joint very long, much curved, especially at some distance from the base, claw-shaped, with fine simple hairs spread along both margins and on the inner side, but without spines; the claw itself is very short.—In the female the legs are much shorter than in the male, robust; process on third joint proportionately a little longer and broader, that on fourth joint a little longer than in the male; fifth joint much smaller than in

the male, its lower process small. Hand much smaller than in the male, subtriangular, a little more than half as long again as deep; upper margin very convex, two and a half times longer than the lower, which is straight, with many long hairs; distal end somewhat longer than the lower margin; palmar edge feebly convex, with an angular notch at the lower end, so that the usual spine, which is strong and moderately long, is situated a little behind the edge; the edge from the "claw" to the notch is occupied by five or six saw-teeth gradually increasing in size downwards, and besides adorned with some stiff setæ pectinate along their upper margin; finally, the angle between lower margin and palmar edge measures about 110° . Seventh joint with the claw regularly claw-shaped, when extended reaching slightly beyond the notch mentioned; the major portion of the lower margin of the joint is adorned with rather slender spines, serrate along the lower margin, and some fine hairs.

Abdominal shield slightly broader than long; lateral margin unarmed, only with the usual tooth and notch at the end; posterior margin, reckoned from the notch, is strongly and rather evenly curved.

Uropoda considerably more than half as long as the abdominal shield; exopod slightly longer than the sympod and much shorter than the endopod.

Second joint of the endopod of second male pleopoda with the distal half considerably broader than near the base, the end very obliquely rounded, the lower surface at the end set with numerous very short hairs.

Length.—Both sexes similar in this respect, measuring about 3.3 mm.

Occurrence. West Indies: St. Thomas. Several specimens, among which five adult males, were taken, 12.II.1888, by H. Kier, Captain in the Danish Navy.

Remarks. In the outline of the head, the position of the eyes, the short third joint in the antennular peduncle, the first pair of legs, and, above all, in the shape of the hand in the male, this form differs abundantly from the preceding species; it is closely allied to the two following species, and the differences are mentioned below.

7. STENETRIUM STEBBINGII H. Richardson.

1902. *Stenetrium stebbingi* Harriet Richardson, Trans. Conn. Acad. vol. xi. p. 295, pl. xxxix. figs. 46–49.

Of this species I have seen no specimens. According to the description and the figures published by Miss Richardson it is very closely allied to *S. occidentale* and *S. antillense*, but the figures representing the first thoracic leg in male and female show some differences which I hope really exist, and if so, they are sufficient for the separation of this form from *S. occidentale* and *S. antillense*.

The figure showing the head with antennulæ and four proximal

joints of antennæ is certainly not correct in several details, especially in the shape of the eyes and of the basal joint of the antennæ, but, so far as I can see, the head with its upper appendages does not present differences of importance from those of my two allied species.

First thoracic legs present real differences. In the male the process from the lower side of the fifth joint is even longer than in *S. occidentale*, and besides not triangular but of about the same depth for two-thirds of its length. The hand is longer and proportionately more slender than in my two species; it agrees with *S. antillense* and differs from *S. occidentale* in having the proximal half of the lower margin convex, but it differs from *S. antillense* in being nearly three times as long as deep, with the proximal half not deeper than the distal one; the palmar edge is occupied by two moderately low, narrow processes with the end bifurcate. (This description is derived from fig. 48; my statement concerning the two bifurcate processes does not agree with the author's description: "... three large spines, the inner one being bifurcate," but I hope that the figure is correct.) In the female the lower process on the fifth joint is longer than in *S. occidentale*; the hand is, according to fig. 49, nearly twice as long as deep, thus more slender than in my two species, besides the angle between the lower margin and the palmar edge is larger, measuring about 125° .

Length has not been stated by Miss Richardson; according to the degree of enlargement of her figures, the species must be larger than *S. antillense* or *S. occidentale*.

Occurrence. Bermudas. Many specimens were taken, at least some of them, "in corallines, at low water."

8. *STENETRIUM ANTILLENSE*, sp. n. Adult male and small immature female. (Plate XX. figs. 3 a-3 i; Plate XXI. figs. 1 a-1 e.)

This species is so closely allied to *S. occidentale* and *S. stebbingii* that it is preferable to point out the differences instead of giving a complete description.

The head is shaped as in *S. occidentale*; the eyes have the same position.

Antennulæ have second and third joints subequal in length; flagellum in the male about as long as the sum of the two preceding joints, with from nine to eleven joints.

Antennæ have their basal joint as in *S. occidentale*.

First thoracic legs show some important differences in their distal half.—In the male the fifth joint is below as much produced as in *S. occidentale*, but the process is differently shaped: its proximal half is expanded above and excavated on the upper half of the outer side in order to receive the proximal lower part of the hand; the oblong-triangular, freely protruding part of the process looks therefore much shorter than in *S. occidentale*, in which it is regularly oblong-triangular and quite free to about the articulation of the hand. The hand is deeper than in *S. occidentale* and

has a different shape; it is slightly more than twice as long as deep, conspicuously deeper at a shorter distance from the base than at the distal end; the upper margin is less convex than in *S. occidentale*, while the lower margin is considerably convex in its proximal and concave in its distal half; the distal process is longer but much narrower than in *S. occidentale*, bifurcate at the end and sometimes with a feeble tooth on its posterior margin; distribution of hairs as in the species mentioned. The "claw," formed by the seventh joint and the claw itself, slightly longer than in *S. occidentale* and more hairy at the lower margin.—In the young—probably also in the adult—female the hand differs somewhat in shape from those of the two preceding species: as in *S. occidentale* it is a little more than half as long again as broad, but the lower margin is comparatively longer, measured to the base of the lower saw-tooth of the palmar edge slightly more than half as long as the upper margin, and the angle between the lower margin and the palmar edge is less than 100° ; the notch at the distal end of the lower margin is longer than in *S. occidentale*.

Abdominal shield is slightly longer than broad, otherwise as in *S. occidentale*.

Uropoda seem to be only a little more than half as long as the abdominal shield; the rami—preserved only in the young female—a little shorter than in *S. occidentale*.

Length of the largest male 4.5 mm.

Occurrence. West Indies. Two adult males and a young female were found on corals presented to the Zoological Museum in Copenhagen by Mr. G. A. Hagemann. The corals were said to be from "deep water," which probably signifies about 100 fathoms.

Remarks. It is certain that *S. occidentale* and *S. antillense* are valid species; having seen no specimens of *S. stebbingii* it has been necessary to rely on Miss Richardson's drawings, and I believe that neither of my species is identical with this form from Bermudas. It may be added that the hand of the first legs in the male is similar to that of the second legs in species of *Ischyrocerus*, a genus of Amphipoda; furthermore that the hand of the female in *Stenetrium* is similar to that of the second legs in species of *Metopa*, another genus of Amphipoda, and in the latter genus specific differences similar to those pointed out in females of *Stenetrium* are well known.

9. *STENETRIUM SIAMENSE*, sp. n. Male and not quite full-grown female. (Plate XXI. figs. 2 a-2 i.)

Body narrower than in the preceding forms, slightly more than four times as long as broad.

Head has its upper surface (the frontal plate excepted) half as broad again as long; the lateral part is not expanded, with the front portion of the lateral margins converging and the angle not produced, obtuse; front margin outside the base of each antennula produced into a broad short triangle with the apex rounded. Eyes small, rounded, placed near the lateral margin.

Antennulæ have the second joint of the peduncle a little shorter than the third and rather slender; flagellum in the male about as long as the sum of the two proximal joints of the peduncle, six-jointed.

Antennæ.—Basal joint is distally cut off transversely, its outer angle without any process measuring more than 90° .

First thoracic legs very different in the two sexes.—In the adult male they are robust and elongate, a little longer than thorax. Third joint is oblong, gradually expanded above and produced into a rather large, oblong, acute process directed forward; fourth joint very large, gradually much expanded above and produced into a large plate-shaped process with the end acute; upper margin and inner side of the expanded part of third and fourth joints with numerous exceedingly long hairs. Fifth joint very large, without dorsal process but strongly expanded below, forming a large subtriangular plate which is slightly produced below in front, with the lower anterior angle rounded and the distal margin nearly as long as the joint; the upper part of the joint is distally vaulted on the exterior side and situated in a much higher plane than the large lower part, which is a thin plate; in this way a kind of excavation, sharply marked off above, is formed on the outer side of the joint, and the hand can be turned downwards and backwards so that a portion of its inner side becomes overlapped by the thin plate of the fifth joint; the lower margin and inner side of this thin plate are furnished with hairs and setæ of very moderate length. The hand is large, not very long but very deep, about $\frac{4}{5}$ as long as deep; from the basal articulation it expands suddenly and strongly downwards so that a free and rather long posterior margin is formed, and the posterior angle is broadly rounded; the upper margin is feebly convex, the lower margin somewhat shorter than the distal end; the palmar edge is very oblique, with two teeth above the middle and a rather small spine at the lower angle which is produced into a triangular tooth; at the palmar edge and on the lower margin a number of setæ of very moderate length. Seventh joint with the claw claw-shaped, rather small and not reaching the lower end of the palmar edge; lower margin of the joint with a row of fine spines.—In the female the first legs are very much smaller than in the male, not elongate. Third and fourth joints as to shape and hairs essentially as in the male, yet somewhat shorter in proportion to length; fifth joint similar to that in the other sex, but the upper angle is produced into a rather short acute process, and the lower plate-like expansion is narrower as compared with the upper portion, which is rather feebly vaulted. The hand is nearly twice as long as deep; the lower margin is rather convex in its proximal half, but a posterior margin, as found in the male, is not developed; the palmar edge is very oblique, and the angle between this edge and the lower margin measures nearly 130° , the edge shows a rudimentary tooth, several stiff setæ pectinate above, and at the lower end a notch so that the usual strong spine

is placed behind the main portion of the edge (as in the females of *S. occidentale* and *S. antillense*). The "claw" reaches just to the end of the edge; its lower margin with a number of fine, scarcely serrate spines.

Abdominal shield slightly longer than broad. The lateral margin unarmed, only with the usual tooth at the notch; posterior margin strongly and evenly convex.

Uropoda wanting in my specimens.

Second joint of the endopod of second male pleopoda increases gradually somewhat in breadth from the base for two-thirds of its length; the distal oval portion is marked off by small lateral indentations, and the outer portion of its lower surface is adorned with a brush of very short fine hairs; the margin turning outwards has a small spine directed forwards a little in front of the indentation named.

Length of an adult male 4 mm., of the largest immature female 3.4 mm.

Occurrence. Gulf of Siam: between Koh Mesan and Koh Chuen, 38 fathoms (one male) and 15 fathoms (two immature females). The specimens were found in sifted bottom material taken by Dr. Th. Mortensen in the beginning of February 1900.

Remarks. This small slender species is easily distinguished from all preceding forms by the small rounded eyes and the complete absence of any process from the lateral margin of the head. First thoracic legs in the male deviate much from those in all other forms hitherto known.

10. *STENETRIUM INERME* Hasw.

1881. *Stenetrium inerme* Haswell, Trans. Linn. Soc. New South Wales, vol. v. p. 480, pl. xix. fig. 2 [*teste* Haswell].

1882. *Stenetrium inerme* Haswell, Catal. Austr. Stalk- and Sessile-eyed Crust. p. 309.

This species is mentioned only for the sake of completeness, because I think that it does not belong to *Stenetrium*. In his 'Catalogue' Haswell describes some characters which raise doubt as to the correctness of his own reference to this genus, the type of which is *S. armatum* Hasw.; tracings of figures* in his first paper corroborate this doubt. According to his fig. 2, the first thoracic segment is laterally not produced into an acute process directed forwards as in all other species; in the text (Catal. p. 309) he says: "Lateral borders of anterior thoracic segments not much produced, bilobed," which thus agrees with the figure. Furthermore, the figure of the maxilliped, the description of the antennule, having their basal joint "very short and broad," and abdomen, having the lateral margin "entire," thus without notch, all these particulars do not agree with features met with in all other species of *Stenetrium*; unfortunately Haswell omits the pleopoda. On hand and "claw" of first thoracic legs

* Kindly forwarded to me a long time ago by Mr. R. I. Pocock, now Superintendent of the Zoological Gardens, London.

he says: "propodos subtriangular in outline, the palm transverse, concave, armed with a few short bristles, and defined by a prominent acute tooth; dactylos much longer than the palm;" this description agrees well with his fig. 2 *c*, but hand and especially the "dactylos" differ much from the structure in all other species of *Stenetrium*, and agree much more with the same parts in males belonging to a genus allied to *Ianira*. The length is "about $\frac{5}{16}$ in." Haswell's type is from Port Jackson.

EXPLANATION OF THE PLATES.

PLATE XIX.

Fig. 1. *Stenetrium armatum* Hasw. (p. 318).

- Fig. 1 *a*. Head with front end of thorax of a female, from above; $\times 19$. *f*., frontal plate; *p*., process from basal joint of antenna; *s*., squama of antenna.
 1 *b*. Distal part of first right thoracic leg of a female, from the exterior side (from behind); $\times 30$.
 1 *c*. Abdomen of a female, from above; $\times 19$. Setæ and uropoda wanting.
 1 *d*. Abdomen of a female, from below; $\times 9$. *a*, first pair of pleopoda constituting a small operculum; *b*, sympod of third pleopoda.

Fig. 2. *Stenetrium mediterraneum*, sp. n. (p. 320).

- Fig. 2 *a*. Head of an adult male, from above; $\times 22$.
 2 *b*. Distal part of first left thoracic leg of an adult male, from the exterior side; $\times 30$.
 2 *c*. Palmar edge of the hand and seventh joint with claw of the leg shown in fig. 2 *b*; $\times 57$.
 2 *d*. Subdistal spines from the lower side of seventh joint of the leg shown in fig. 2 *b*; $\times 212$.
 2 *e*. Spine from lower end of palmar edge of the leg shown in fig. 2 *b*; $\times 212$.
 2 *f*. Distal part of first left thoracic leg of an adult female, from the exterior side; $\times 30$.
 2 *g*. Abdomen of an adult male, from above; $\times 20$.
 2 *h*. Second left pleopod of an adult male, from in front; $\times 45$.

Fig. 3. *Stenetrium serratum*, sp. n.; adult female (p. 323).

- Fig. 3 *a*. Head, from above; $\times 22$.
 3 *b*. Lateral part of the two anterior thoracic segments with their legs, from above; $\times 22$.
 3 *c*. Distal part of first left thoracic leg, from the outer side (from behind); $\times 63$.
 3 *d*. Distal part of sixth joint, seventh joint, claw and spine below the claw of second left thoracic leg shown in fig. 3 *b*; $\times 79$. *s*., exceedingly broad spine inserted at the end of sixth joint on its posterior side, and overlapping the proximal portion of seventh joint.

PLATE XX.

Fig. 1. *Stenetrium serratum*, sp. n. (continued) (p. 323).

- Fig. 1 *a*. Abdomen of an adult female, from above; $\times 15$. Uropoda wanting.

Fig. 2. *Stenetrium occidentale*, sp. n. (p. 324).

- Fig. 2 *a*. Left antennula of an adult male, from above; $\times 39$.
 2 *b*. First left thoracic leg of an adult male, from the exterior side (from behind); $\times 39$.
 2 *c*. First left thoracic leg of an immature male, from the exterior side; $\times 39$.
 2 *d*. First left thoracic leg of an adult female, from the exterior side; $\times 39$.
 2 *e*. Palmar edge and seventh joint with claw of the leg shown in fig. 2 *d*, from the interior side; $\times 97$.
 2 *f*. Abdomen of an ovigerous female, from above; $\times 28$.
 2 *g*. First pair of pleopoda of an adult male, from in front; $\times 51$. *m*., muscle to the ramus.

- Fig. 2*h*. Left pleopod of second pair of the same male, from in front; $\times 51$. The muscles in the sympod are seen.
- 2*i*. Left pleopod of third pair of the same male, from in front; $\times 51$.
- 2*k*. Left pleopod of fourth pair of the same male, from in front; $\times 51$.
- 2*l*. Left pleopod of fifth pair of the same male, from in front; $\times 51$.
- 2*m*. First pair of pleopoda, constituting a small operculum, of an adult female, from in front; $\times 51$.
- 2*n*. Left pleopod of third pair of the same female, from in front; $\times 51$.

Fig. 3. *Stenetrium antillense*, sp. n. (p. 326).

- Fig. 3*a*. Left mandible of a male, from below; $\times 49$.
- 3*b*. Distal part of the mandible shown in fig. 3*a*, from below; $\times 125$.
- 3*c*. Distal part of right mandible of the same male, from below; $\times 125$.
- 3*d*. Hypopharynx (paragnatha) of the same male, from below; $\times 49$.
- 3*e*. Left maxillula of the same male, from below; $\times 49$.
- 3*f*. Distal part of the lobe from third joint of the maxillula shown in fig. 3*a*, from below; $\times 185$.
- 3*g*. Left maxilla of the same male, from below; $\times 49$.
- 3*h*. Left maxilliped of the same male, from below; $\times 49$.
- 3*i*. Distal portion of first left thoracic leg of an immature female, from the exterior side; $\times 53$.

PLATE XXI.

Fig. 1*a*. *Stenetrium antillense*, sp. n. (continued) (p. 326).

- Fig. 1*a*. Adult male, from above; $\times 9$. Several appendages omitted.
- 1*b*. Head of the adult male shown in fig. 1*a*, from above; $\times 24$.
- 1*c*. First left thoracic leg of the adult male shown in fig. 1*a*, from the exterior side; $\times 16$.
- 1*d*. Major part of fifth joint and prehensile hand of first right thoracic leg of another male, from the exterior side; $\times 28$.
- 1*e*. Abdomen of an immature female, from above; $\times 36$.

Fig. 2. *Stenetrium siamense*, sp. n. (p. 327).

- Fig. 2*a*. Head of an adult male, from above; $\times 33$.
- 2*b*. First right thoracic leg of an adult male, from the exterior side (from behind); $\times 33$.
- 2*c*. First right thoracic leg of a not quite full-grown female, from the exterior side; $\times 33$.
- 2*d*. Palmar edge and "claw" of the leg shown in fig. 2*c*, from the exterior side; $\times 86$.
- 2*e*. Abdomen of an adult male, from above; $\times 28$. Uropoda wanting.
- 2*f*. First pair of pleopoda of an adult male, from in front; $\times 50$. *m.*, muscle to the ramus.
- 2*g*. Second left pleopod of an adult male, from in front; $\times 50$.
- 2*h*. Distal part of the sympod, endopod, *en.*, and exopod, *ex.*, of the pleopod shown in fig. 2*g*, from in front; $\times 95$. In the sympod the muscles for the movement of both rami are shown.
- 2*i*. First pair of pleopoda, constituting a small operculum, of a not quite full-grown female, from in front; $\times 50$.

Figs. 3-6. *Parts of various Asellota.*

- Fig. 3. Distal part of sympod with both rami of second left pleopod of the male of *Asellus aquaticus* L., from in front; $\times 54$ (p. 306). Three muscles to the rami are shown in the sympod; in the first joint of the endopod a muscle to the second joint is seen, in the distal joint of the exopod a muscle producing the movement of this joint is plainly visible. The dotted line on the distal joint of the endopod indicates the outline of the sac within.
4. First pair of pleopoda and second right pleopod of a male of an undescribed form rather allied to *Ianira*, seen from in front; $\times 43$ (p. 309). *r.*, ramus, and *s.*, sympod of first left pleopod; *t.*, second pleopod, with the short hook-shaped exopod, while the elongate endopod has been omitted.
5. First pair of pleopoda of a male of *Ianira maculosa* Leach, from in front; $\times 32$ (p. 309). *r.*, ramus; *s.*, sympod.
6. Distal inner part of left second pleopod of a male of *Eurycope gigantea* G. O. Sars, from in front; $\times 12$. *b.* (p. 309), basal joint of endopod divided into two parts or joints; *c.* (p. 309), cavity within the distal joint of the endopod; *d.* (p. 312), duct from this cavity; *ex.*, two-jointed exopod.

5. On the *Lacerta depressa* of Camerano.

By G. A. BOULENGER, F.R.S., V.P.Z.S.

[Received October 20, 1904.]

(Plate XXII.*)

Much work has been done lately on the various forms which cluster round the common *Lacerta muralis* of Europe, and the younger herpetologists have shown an ever increasing inclination towards multiplying species. Whether this narrower conception of species will result in a better understanding of the distribution and phylogeny of this difficult group, is a question I will not at present discuss. But I may say that these recent systematic attempts seem to justify the view expressed by Dr. Günther thirty years ago †, that "Such nominal species rarely survive their author; but before they are merged again in the synonymy, they are the cause of much unnecessary trouble, and being founded on slight individual peculiarities, they are frequently mistaken, rarely recognised."

The history of *Lacerta depressa* illustrates the case in point.

Some time ago I received from my friend Dr. F. Werner a lizard from the Bithynian Olympus, near Brussa (altitude 1500–1800 metres), which he referred to *L. depressa* of Camerano, and particularly to the var. *rudis* of Bedriaga. An account of this and other specimens of the same form is given by Werner in his valuable paper on the Reptiles of Asia Minor ‡. This lizard differs so considerably from the specimen of *L. depressa* (one of the types, received from the Turin Museum) preserved in the British Museum, that I could not satisfy myself of the correctness of Werner's identification, notwithstanding his express statement that this was arrived at after comparison of one of the types from Trebizond, entrusted to him by the Turin Museum.

In order to clear up my doubts, I applied to my friend Prof. Camerano for the loan of the specimens of *L. depressa* § preserved in the Museum under his charge; and my request having been kindly granted, I wish to lay before the Society the result of my examination.

This shows that, as could be gathered from Bedriaga's description ||, the species is made up of several distinct forms (I would call them varieties). There is no evidence that the specimens all came from Trebizond, for De Filippi, their collector, himself says of the species referred to *L. taurica* ¶, "trovanno commune da Trebisonda a Tiflis." It is remarkable that the descriptions of both Camerano and Bedriaga, who had access to all the specimens,

* For explanation of the Plate, see p. 339.

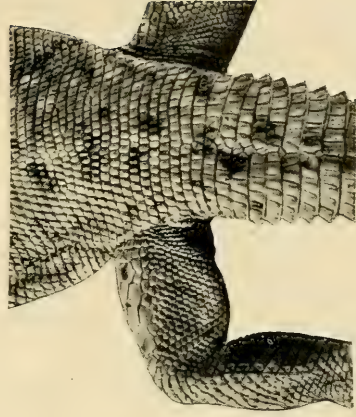
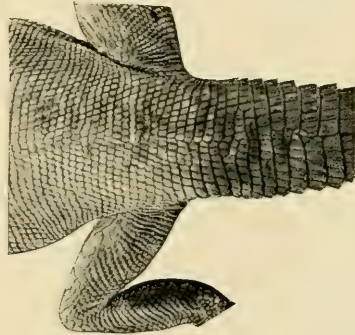
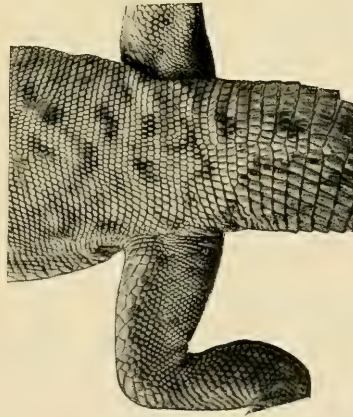
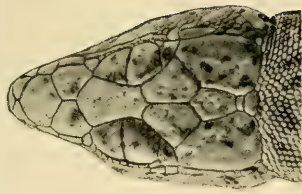
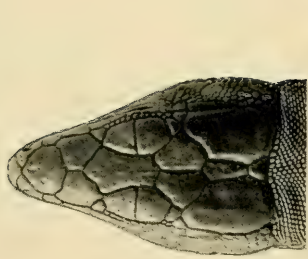
† Introduction to Catalogue of Fishes, viii. p. vi.

‡ Sitzb. Ak. Wien, cxi. 1902, p. 30, pl. iii.

§ *Podarcis depressa*, Camerano, Atti Acc. Torin. xiii. 1878, p. 539.

|| Abh. Senck. Ges. xiv. 1886, p. 272.

¶ Arch. per la Zool. ii. 1863, p. 386.



J.Green photo.

a.

LACERTA DEPRESSA Camerano

b.

c.

D.Macbeth Sc.

six in number*, though very detailed, do not cover by any means the variations which the specimens show. I quite agree with Boettger† in regarding *L. depressa* and its varieties as not specifically separable from the *L. muralis* of S.W. Asia, which embraces the forms named *L. chalybdea*, *L. saxicola*, *L. portschinskii*, and *L. defilippii*. With these forms I propose to deal elsewhere, and my object on the present occasion is merely to give accurate descriptions of the individual specimens which are the types of *L. depressa*. One of them is in the British Museum, one has passed into the collection of Dr. de Bedriaga and is not available to me at present, whilst the four others are preserved in the Turin Museum. I deal with the five specimens in order of size.

1. *Male*.—Snout obtusely pointed; the greatest depth of the head equals the distance between the eye and the tympanum. Rostral not entering the nostril, forming a narrow suture with the frontonasal‡; frontal as long as its distance from the end of the snout; a complete series of granules between the two principal supraoculars and the supraciliaries; fourth supraocular divided into two; parietals once and a half as long as broad, not in contact with the upper supraocular§; the upper border of the parietal very slightly concave in front for the accommodation of a rather large upper temporal shield; occipital half as long, but a little broader than the interparietal; temporal scales small and granular; tympanic and masseteric shields well developed, the latter oval, oblique, and separated from the upper temporal by two series of granules; four upper labials anterior to the subocular, the lower border of which is nearly as long as the upper.

Collar even-edged, composed of 11 plates; 31 scales on a line between the symphysis of the chin-shields and the median plate of the collar.

Body much depressed. Dorsal scales roundish-hexagonal, flat, faintly keeled on posterior part of back; 60 scales across the middle of the body, 3 or 4 transverse series corresponding to a ventral plate, 44 to the length of the head. Ventral plates in 6 longitudinal and 26 transverse series. Anal plate preceded by a nearly equally large shield, the two plates bordered by a semi-circle of 9 small plates.

Hind limb reaching the collar. Scales on upper surface of tibia rhomboidal, keeled, and a little larger than the dorsals, 8 transverse series of the former corresponding to 10 of the latter. Femoral pores 22–21. 27 lamellar scales under the fourth toe.

Upper and lateral scales at the base of the tail strongly keeled, those on the sides raised behind, subtrigonal, squarely truncate; the whorls alternately longer and shorter, but not very markedly

* Bedriaga says seven, but this is probably through a *lapsus calami*.

† Ber. Senck. Ges. 1892, p. 141.

‡ As occurs sometimes in both the *f. typica* and the var. *bedriaga*.

§ Méhely, Ann. Mus. Hung. ii. 1904, p. 367, has strangely overrated the systematic importance of this character, which is inconstant not only in Asiatic examples but also in the European (numerous exceptions from France, Spain and Portugal, Italy, Islands of Mediterranean) and North African.

so; the fourth whorl behind the postanal small scales contains 29 scales.

Back spotted all over; sides darker, with whitish ocellar spots; upper surface of head unspotted; labials black-edged; uniform white beneath.

2. *Female*.—Head as in the preceding specimen, but smaller and less strongly depressed, its greatest depth equalling the distance between the centre of the eye and the tympanum. Rostral as in the preceding, but separated from the frontonasal, the nasals forming a short median suture; frontal, supraciliary granules, and parietals as in the preceding; fourth supraocular undivided; occipital very short, a little narrower than the interparietal, and separated from it by an additional shield; masseteric shield separated from the upper temporal shield by a single series of granules; five anterior upper labials; subocular as in the preceding.

Collar even-edged, composed of 9 plates; 25 scales between the chin-shields and the collar.

Body much depressed. Dorsal scales oval and distinctly keeled; 51 scales across the middle of the body, 3 corresponding to a ventral plate, 35 to the length of the head. Ventral plates in 6 longitudinal and 27 transverse series. Anal plate preceded by a large but narrower plate and bordered on each side by 3 small plates.

Hind limb reaching the axil. Scales on upper surface of tibia rhomboidal and strongly keeled, much larger than the dorsals, 6 of the former corresponding to 10 of the latter. Femoral pores 18–18. 25 scales under the fourth toe.

Upper caudal scales very strongly keeled, those on the sides raised, subtrigonal, almost spinose, truncate behind; the whorls alternately longer and shorter, and the scales of the two median dorsal series of every other whorl much wider than the others; 28 scales in the fourth whorl.

The black spots form two irregular series along the middle of the back; a dorso-lateral series of white black-edged ocelli; a large ocellus above the shoulder; black dots on the head; the labials black-edged; lower parts uniform white.

3. *Gravid female**.—Head very small and even rather more depressed than in specimen No. 1, its greatest depth hardly equalling the distance between the eye and the tympanum; snout acutely pointed. Rostral not entering the nostril and separated from the frontonasal by the nasals, which form a rather long median suture; frontal as long as its distance from the end of the snout; a complete series of granules between the two principal supraoculars and the supraciliaries; parietals once and half as long as broad, in contact with the upper postocular, the outer border nearly straight; three small occipitals in a transverse line; temporal scales small and granular; tympanic and masseteric shields well

* Boettger was therefore not justified in saying (Ber. Senck. Ges. 1889, p. 205) of *L. depressa*: "Sowohl De Filippi, als auch Camerano, v. Bedriaga und Boulenger kannten nur die mehr graugrün oder olivengrau gefärbte Jugendform derselben."

developed, the latter oval, oblique, and separated from the upper temporal shield by one series of granules; four upper labials anterior to the subocular, the lower border of which is nearly as long as the upper.

Collar even-edged, composed of 10 plates; 31 scales between the chin-shields and the collar.

Body much depressed. Dorsal scales round and flat, perfectly smooth, 54 across the middle of the body, 3 or 4 corresponding to a ventral plate, 31 to the length of the head. Ventral plates in 6 longitudinal and 29 transverse series. Anal plate preceded by a large but narrower plate and bordered on one side by two small plates, on the other by three.

Hind limb reaching the wrist of the adpressed fore limb; scales on the upper surface of the tibia round, feebly keeled, considerably smaller than the dorsals, 14 of the former corresponding to 10 of the latter. Femoral pores 17-18. 28 scales under the fourth toe.

Caudal scales as in specimen No. 2, but the keels somewhat less developed.

Uniform greyish above, with mere traces of dark spots and ocelli on the sides (bleached?); labials not dark-edged; lower parts white.

4. *Female*.—Head as in a typical *L. muralis*, its depth equal to the distance between the centre of the eye and the tympanum; snout obtusely pointed. Rostral not entering the nostril and separated from the frontonasal by the nasals, which form a rather long median suture; frontal as long as its distance from the end of the snout; a complete series of granules between the two principal supraoculars and the supraciliaries; parietals once and a half as long as broad, not in contact with the upper postocular, the outer border very slightly concave for the accommodation of the large upper temporal; occipital not quite half the length of the interparietal but a little broader; temporal scales small and granular; tympanic shield well developed; masseteric shield very small, separated from the upper temporal by two or three series of granules; four upper labials anterior to the subocular, which is considerably narrower beneath than above.

Collar even-edged, formed of 10 plates; 25 scales between the chin-shields and the collar.

Body moderately depressed. Dorsal scales round, flat, perfectly smooth, 48 across the middle of the body, 3 corresponding to a ventral plate, 35 to the length of the head. Ventral plates in 6 longitudinal and 28 transverse series. Anal plate bordered by a semicircle of 4 rather large plates.

Hind limb reaching elbow of adpressed fore limb. Scales on upper surface of tibia round, smooth, smaller than the dorsals, 12 of the former corresponding to 10 of the latter. Femoral pores 16-16. 26 scales under the fourth toe.

Caudal scales moderately keeled, as in a typical *L. muralis*; 32 scales in the fourthth whorl.

Black dots irregularly disposed on the middle of the back; a dark lateral streak, formed of confluent vermicular spots, enclosing light ocelli above the shoulder; upper surface of head without spots; labials not dark-edged; lower parts white.

5. *Male**.—Shape of head and head-shields as in specimen No. 1, but nasals forming a short suture behind the rostral, fourth supraocular undivided, and lower border of subocular distinctly shorter than upper.

Collar even-edged, composed of 8 plates; 32 scales between the chin-shields and the collar; gular fold very indistinct†.

Body much depressed. Dorsal scales roundish-hexagonal, flat, smooth, very faintly keeled on posterior part of back; 61 scales across the middle of the body, 3 or 4 corresponding to a ventral plate, 42 to the length of the head. Ventral plates in 6 longitudinal and 25 transverse series. Anal bordered by a semicircle of 8 small shields, the right median of which is twice as large as the left.

Hind limb reaching the shoulder. Scales on upper surface of tibia rhomboidal, keeled, and a little larger than the dorsals, 8 transverse series of the former corresponding to 10 of the latter. Femoral pores 18–18. 26 scales under the fourth toe.

Caudal scales as in No. 1, but the whorls more distinctly unequal in length, alternately longer and shorter; 26 scales in the fourth whorl.

The specimen is much bleached; in what remains of the markings it agrees with No. 1.

The following measurements are taken from the five specimens, in all of which the tail is either reproduced or partly broken off:—

	1.	2.	3.	4.	5.
	mm.	mm.	mm.	mm.	mm.
From snout to vent	68	60	53	53	52
" " fore limb ...	28	23	18	19	21
Length of head	17	15	11	12	13
Width of head	11	9	7	7½	8
Depth of head	6	6	4	5½	5
Fore limb	23	20	16	16	19
Hind limb	40	32	24	24	28
Foot	20	17	14	14	16

The first and largest specimen, the male of which measurements have been given by Camerano‡, having smaller dorsal scales (60 in a transverse series), less spinose caudal scales, and 22–21 femoral pores, clearly represents Bedriaga's var. *modesta* §, and is identical with the smaller male specimen referred to as

* The specimen preserved in the British Museum.

† Quite distinct in the other specimens.

‡ The female specimen of which comparative measurements have been given is evidently the one which has passed into Dr. de Bedriaga's private collection.

§ Bedriaga divided the species into two varieties: *modesta* and *rudis*. The name *modesta* had been previously proposed for a variety of *L. muralis* by Eimer.

L. depressa in the British Museum Catalogue of Lizards*. Should Camerano's species be broken up into several forms, this specimen must be regarded as the restricted type of *L. depressa*. It is probably from Trebizond, since Boettger's specimens from that locality agree closely with it†; but it must be noted that specimens from Shusha, E. Karabagh, received from the Senckenberg Museum as *L. muralis*, var. *defilippii* Boettger‡, belong, in my opinion, to the same variety. Méhely's var. *depressa* from Shion in Transcaucasia§ is also probably the same thing.

The second specimen, with larger dorsal scales (51 across the body), with larger and more strongly keeled scales on the tibia, with more strongly raised keels on the caudal scales, and with 18 femoral pores, has been specially selected by Bedriaga as the type of var. *rudis*. But it is remarkable that no allusion should have been made to its having five anterior labials instead of four, the number unreservedly given in the diagnosis of *L. depressa*. The specimen from Batoum noticed by Boettger is probably correctly referred to this form; it has 5 anterior labials on one side, 4 on the other, and 46 scales across the body.

The third specimen answers in all important respects to the figure of *L. portschinskii* of Kessler¶, from Tiflis, the Russian description of which was translated in 1879 by Bedriaga**. Bedriaga then identified *L. portschinskii* with *L. depressa*; he afterwards in his monograph published in 1885, most emphatically repudiated this identification and placed *L. portschinskii* simply in the synonymy of his *L. muralis fusca*, whilst regarding *L. depressa* as a distinct species having much less in common with *L. muralis* than with *L. oxycephala*††.

The fourth specimen agrees entirely with the Persian lizards described by De Filippi and by Blanford, and may be referred to the var. *defilippii* Camerano, of which var. *persica* Bedriaga, is a synonym.

The fifth specimen, as stated above, should be referred to the var. *depressa*, *sensu stricto*.

Comparing the *L. depressa* of Werner with these specimens, I find it does not agree with any of them, differing in the shorter limbs, a character emphasised by Werner in his description. But it agrees with specimens from Lake Gokcha which, in my opinion, represent the *L. chalybdea* of Eichwald (*L. muralis*, var. *saxicola* Bedriaga). In the following table I give the measure-

* Vol. iii p. 34 (1887).

† Ber. Senck. Ges. 1892, p. 141. 58-60 scales across body, 30-32 gular scales, 8 tibial scales corresponding to 9 or 10 dorsals.

‡ *L. c.* p. 144. These Shusha specimens are regarded by Boettger as connecting the var. *defilippii* Camer. with the var. *raddii* Boettg.

§ Dritte Asiat. Forschungs. Graf. E. Zichy, ii. Zool. p. 54 (1901).

¶ Ber. Senck. Ges. 1889, p. 204.

¶ Tr. St. Petersburg. Soc. Nat. viii. 1878, p. 160, pl. i.

** Arch. f. Nat. 1879, p. 308.

†† The British Museum possesses a quite similar specimen from Elizabethpol, among several received from the St. Petersburg Museum, the largest of which agrees with Eversmann's figure of *L. saxicola*.

ments of two female specimens of the same size, the first of which is one of Dr. Werner's *L. depressa* from the Bythynian Olympus, near Brussa, altitude 1500 m.; the second forms part of a small series from Yelenowka, Lake Gokcha, altitude 2000 m., received from the St. Petersburg Museum in 1886. Scaling and coloration, in these two examples, are practically identical:—

	1. mm.	2. mm.
From snout to vent	70	70
" " to fore limb	22	22
Length of head	15	14
Width of head	10	9
Depth of head	6	6
Fore limb	20	21
Hind limb	29	30
Foot	15	16

On the other hand, I shall surprise many by stating that I have before me a female collected by Dr. Gadow in the Serra Estrella, Portugal, which, in form, coloration, and lepidosis, is, with exception of the tibial and caudal scales, a very good match for the var. *rudis* of *L. depressa*. The wall-lizard from the High Pyrenees, mentioned by Bedriaga and suspected by Méhely to represent a distinct species, is much nearer to the typical form, from which it should certainly not be separated. Curiously, its collector, Lataste, was struck with its general resemblance to *L. vivipara*, just as Werner was when observing his supposed *L. depressa* on the Olympus near Brussa.

Since writing these notes, I have received, through the kindness of Dr. A. N. Kaznakoff, Director of the Caucasian Museum, Tiflis, a female specimen from Tchorok, Caucasus (Coll. Radde & König) which entirely agrees with the var. *rudis*. The scales on the tibia are very large, rhomboidal, strongly keeled; 6 oblique series correspond to 10 transverse series of dorsal scales; the latter are very distinctly keeled, and number 45 across the middle of the body. Four upper labials anterior to the subocular; rostral shield forming a suture with the frontonasal; first and fourth supraoculars broken up into three small shields; parietal not touching the upper postocular. Femoral pores 18–17. 26 lamellar scales under the fourth toe. The hind limb reaches the shoulder. The plate in front of the preanal transversely enlarged.

[P.S. Jan. 9, 1905.—Thanks to the kindness of my friend Dr. de Bedriaga, I have been able to examine the female specimen, alluded to above, still preserved in his private collection. It belongs to the var. *rudis*, having 52 scales across the middle of the body, very large and strongly keeled tibial scales, and almost spinose scales on the sides of the base of the tail. The only important characters in which it differs from the female No. 2 are the presence of only four anterior upper labials and the

absence on one side, and the very small size on the other, of the masseteric shield. Femoral pores 17-19. From snout to vent 70 millim.

Dr. de Bedriaga has also sent me on loan a large male, measuring 83 millim. from snout to vent, from Batoum, received from the St. Petersburg Museum, which also belongs to the var. *rudis*. The cheeks are much swollen, and the depth of the head equals the distance between the centre of the eye and the anterior border of the tympanum. The hind limb reaches the shoulder. 45 scales across the middle of the body. 21-22 femoral pores. 25 scales under the fourth toe. Rostral forming a narrow suture with the frontonasal. Only three labials anterior to the subocular. This specimen, which I have carefully compared with Bedriaga's *L. depressa*, var. *rudis*, confirms Boettger's identification of a Batoum specimen in 1889.]

EXPLANATION OF PLATE XXII.

Three of the type specimens of *Lacerta depressa*, Camerano; enlarged figures showing upper and side views of head and posterior part of back, with hind limb and base of tail.

a. Male (no. 1, p. 333) $\times 2$; b. Female (no. 3, p. 334) $\times 2\frac{1}{2}$;

c. Female (no. 2, p. 334), $\times 2$.

6. On Old Pictures of Giraffes and Zebras.

By R. LYDEKKER.

[Received October 7, 1904.]

(Text-figures 85-89.)

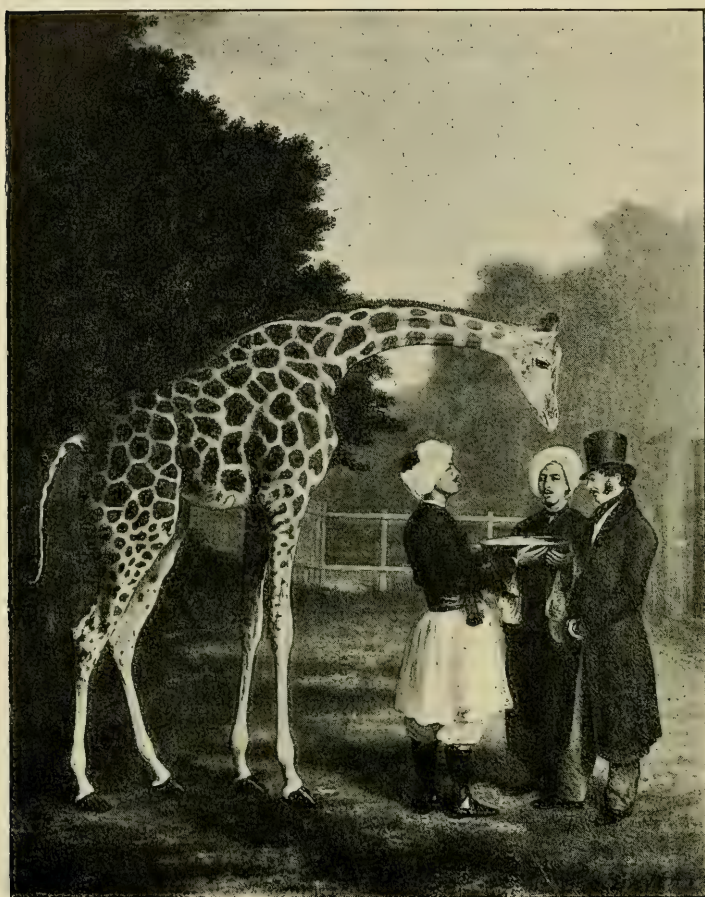
The Natural History Branch of the British Museum has recently received from the Lord Chamberlain, through Mr. Lionel Cust, Surveyor of the King's Pictures and Works of Art, four photographs from paintings of Giraffes and a Zebra preserved in the Royal Collection, some of which are of considerable interest from an historical point of view.

The painting from which text-figure 85 is taken represents an immature Nubian Giraffe presented in 1827 by Mohamed Ali, Pasha of Egypt, to his Majesty George the Fourth. This animal, which survived but a short time at Windsor, was the first received alive in Britain, and one of the four first imported into Europe in modern times. Of its three fellows, one was sent by the Pasha to the Sultan of Turkey, the second to Vienna, and the third to Paris, where it attracted an enormous amount of attention*. Although, owing to the immature condition of the animal, the frontal horn is not fully developed, the painting displays all the characteristics of the typical Nubian race of *Giraffa camelopardalis*, such as the net-like style of the markings, the white "stockings," and the comparatively large size of the spots on the upper part of the legs. A portrait of Mr. Cross, the

* See Renshaw, 'Natural History Essays,' p. 105 (1904).

animal-dealer, is introduced into this picture, which is the work of James Laurent Agasse.

Text-fig. 85.



George the Fourth's Nubian Giraffe at Windsor.
(From a Painting in the Royal Collection.)

The first picture (text-fig. 85) represents the animal in its surroundings at Windsor; the painting reproduced in text-fig. 86 depicts, on the other hand, a Giraffe in its native country, or what is intended therefor. Whether this painting portrays the same animal as the first it is not easy to determine. Apparently, however, the portrait is that of a Nubian Giraffe, although it is by no means so good as the first; the animal apparently had

a distinct frontal horn, although it is much concealed by the halter.

Text-fig. 86.



George the Fourth's Nubian Giraffe in its native country.
(From a Painting in the Royal Collection.)

The third picture (text-fig. 87) represents a group of Giraffes which appear to be intended for the Southern or Cape form (*G. c. capensis*), as the old bull has no frontal horn, while the markings are of the blotched instead of the netted type, and the lower parts of the legs are spotted, although not quite so fully as they ought to be. The painting, which is by R. B. Davis, and dated September 1827, is described, however, as representing "two Giraffes belonging to George IVth;" but on the back is

written "portrait of the Giraffe belonging to his Majesty." It is difficult, however, to believe that the artist did not take a portrait of the Cape Giraffe for his model, and he may have copied Paterson's specimen in the British Museum. If, as I think, it represents the Cape Giraffe, the painting is of very considerable

Text-fig. 87.



Group of Cape (?) Giraffes.
(From a Painting in the Royal Collection.)

interest, as that race now appears to be extinct. Both Agasse and Davis were well-known animal painters in the first quarter of the last century.

The fourth painting (text-fig. 88) represents a specimen of the Mountain Zebra (*Equus zebra*) in two positions; the characteristic

"gridiron" on the rump, the broad stripes on the thighs, and the white under-parts being remarkably well shown. The picture is

Text-fig. 88.

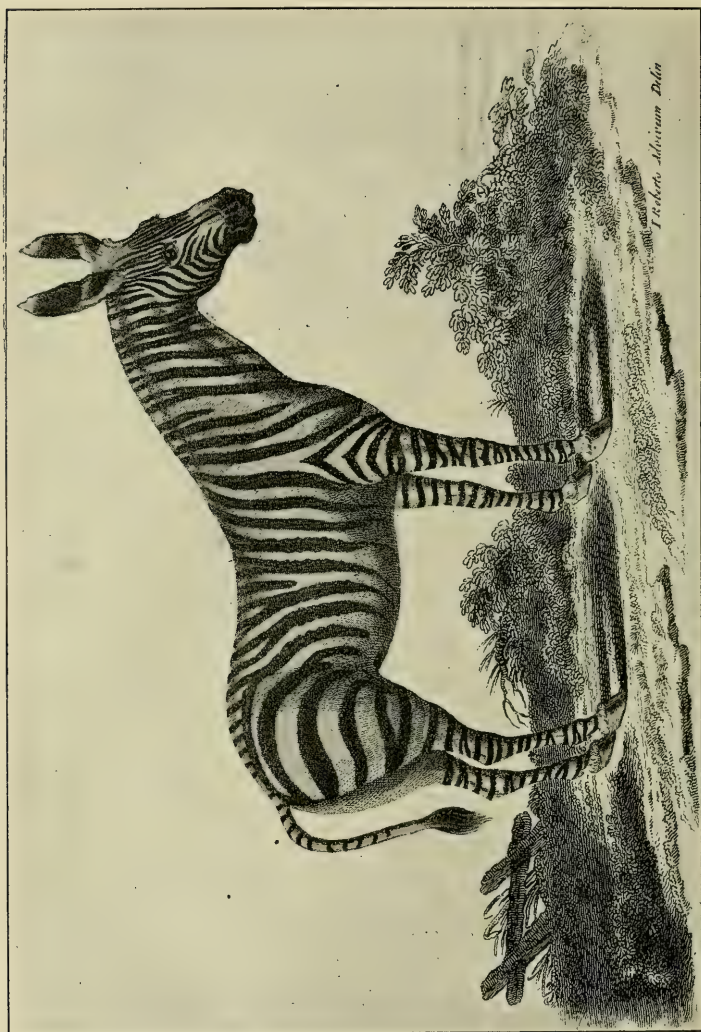


Mountain Zebra. (From a Painting in the Royal Collection.)

stated to have been drawn from life at the Hague by C. Kehrér; but there is no record at Windsor of the original model having

been there. Carl Christian Kehrer, who painted hunting-scenes and portraits, and is, I take it, the painter in question, was born in 1758 and died in 1833.

Text-fig. 89.



Queen Charlotte's Mountain Zebra. (From an Old Print.)

In this connection I may mention that a few years ago my friend Dr. F. H. H. Guillemard sent me a copy of an old print bearing the following legend:—

“The portraiture of the Zebra or Wild Ass, drawn from the life. This beautiful animal was brought from the Cape of Good



1.



3.



4.



2.

Hope by Sir Thomas Adams in the *Terpsicore* Man-of-War and presented to her Majesty [Queen Charlotte]. 1762."

I think there is considerable probability that this print (text-fig. 89) and the royal picture were taken from one and the same animal, although the general drawing and the details of the stripes are far less true to nature in the former than in the latter; but Kehrer's portrait could not have been done at the Hague while the animal was *en route* for England, and there is no record of its having been taken there later. If both pictures represent the same animal, Queen Charlotte's Zebra, as the individual represented in the old print may be called, appears to have been the first of its kind ever brought to England.

7. On Two Lorises. By R. LYDEKKER.

[Received October 31, 1904.]

(Plate XXIII.*)

The Trustees of the British Museum have recently purchased from Rowland Ward, Ltd., two mounted specimens of Lorises belonging to forms hitherto unfigured, and one of which I regard as new; the first specimen being a Slow Loris (*Nycticebus*), and the second a Slender Loris (*Loris*). Both of these genera, it may be observed, appear to be represented only by a single species, if we except the ill-defined *N. menagensis* of the Philippines. Whereas, however, several local forms of the Slow Loris have been recognised, the Slender Loris has hitherto been undivided.

As regards the Slow Loris, Messrs. Stone and Rehn, in the 'Proceedings' of the Philadelphia Academy for 1902 (pp. 138 & 139), recognised five local forms, namely, *Nycticebus tardigradus* † *typicus* of India, *N. t. javanicus*, *N. t. malayanus*, *N. t. natunæ*, and *N. t. hilleri* (of Sumatra); the two last being described for the first time. In addition to these there is the Tenasserim form, of which no examples were at the time available.

The first two of the five races mentioned above are grouped together in a section characterised by the general colour being ashy grey, slightly tinged with rufous, while the crown of the head is not marked by a large patch of brown. In the three remaining races, on the other hand, the general colour is rufescent grey, and the crown of the head has a large brown patch. Omitting mention of the Natuna Islands' form, the Malay race—as represented in the collection of the British Museum by three mounted specimens from Penang (Pl. XXIII. fig. 1), the gift of Capt. Stanley Flower—is characterised by the general rufescent grey tone of the fur, and the strongly pronounced rufous-brown crown-patch and dorsal stripe ‡. This crown-patch has a pair of lines extending transversely outwards to the ears, and another

* For explanation of the Plate, see p. 346.

† Messrs. Stone & Rehn substitute the name *coucang*.

‡ This does not accord with Messrs. Stone & Rehn's description.

and broader pair passing obliquely downwards to the eyes, which they encircle. Above the eyes the white interocular stripe expands markedly.

A very different-looking creature is the Sumatran Slow Loris (*N. t. hilleri*), now, I believe, for the first time figured (Pl. XXIII. fig. 2). In this race the general colour is bright rufescent chestnut slightly washed with grey; the dorsal stripe and crown-patch being a deeper rufous, faintly bordered with brown, and on the whole less distinct than in *N. t. malayanus*. The crown-patch is much less distinctly divided into two pairs of lines than in the latter; the blotches over the eyes being much broader, and the interocular white streak consequently much reduced in width. The plate illustrates very clearly the marked distinction between the grey Malay phase and the rufous Sumatran phase of the species; it would be interesting to know the reason for this very strongly marked local difference in colour.

Passing on to the Slender Loris (*Loris gracilis*), I find that in the typical Indian form of this animal, as represented by a couple of mounted specimens from Madras recently presented to the British Museum by Mr. E. Thurston (Pl. XXIII. fig. 3), the general colour is pale mouse-grey passing into pure white between the eyes, on the sides of the face, under-parts, &c. On the face the white interocular streak extends some distance on the forehead above the line of the eyes, and then divides into a pair of bands which pass outwards in front of the eyes, and thus cut off a small patch above each of the latter from the grey of the rest of the head. These patches are practically restricted to the areas above the eyes, there being little or no grey fur on the outer side of and below the latter.

The Ceylon Loris, on the other hand, of which the British Museum has recently purchased a mounted specimen (Pl. XXIII. fig. 4), is a rufous instead of pale grey animal; the general colour of the upper-parts and eye-patches being pale rufescent brownish grey silvered with white; the crown and back being darker than elsewhere. Moreover, the eye-patches are much larger, the brown extending round the outer side of the orbits to occupy a considerable area below them. Again, with the exception of the interocular stripe and the sides of the face (and even these are by no means pure white) the under-parts are cream-colour or pale buff, instead of white. These differences, I submit, amply demonstrate the right of the Ceylon Loris to subspecific distinction, and I accordingly propose to call it *Loris gracilis zeylanicus*, taking the British Museum specimen as the type.

EXPLANATION OF PLATE XXIII.

- Fig. 1. Head of *Nycticebus tardigradus malayanus* (p. 345).
2. Head of *Nycticebus tardigradus hilleri* (p. 346).
3. Head of *Loris gracilis typicus* (p. 346).
4. Head of *Loris gracilis zeylanicus* (p. 346).
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December 13, 1904.

HERBERT DRUCE, Esq., F.Z.S., Vice-President,
in the Chair.

The Secretary read the following report on the additions to the Society's Menagerie during the month of November 1904:—

The number of registered additions to the Society's Menagerie during the month of November was 150. Of these 68 were acquired by presentation and 14 by purchase, 26 were received on deposit, 34 in exchange, and 8 were bred in the Menagerie. The number of departures during the same period, by death and removals, was 179.

Amongst these, special attention may be called to the following:—

1. A Ferret Badger (*Helictis personata*) from Burmah, presented by Capt. Burnett on Nov. 4th. This species has not been exhibited previously in the Gardens.

2. Two Chimpanzees (*Anthropopithecus schweinfurthi*), a male and female, from the Bagomo Forest, Uganda, presented by Mr. Stanley C. Tomkins, C.M.G., on Nov. 7th. These animals are nearly adult, the male being the finest Chimpanzee ever shown in the Gardens.

3. A male specimen of the Senegal race of the African Buffalo (*Bubalus centralis*), deposited on Nov. 21st. No example of this subspecies has been exhibited previously in the Menagerie.

4. Three Mouse-Hares (*Ochotona roylei*) from Baluchistan, presented by Col. Chas. E. Yates on Nov. 28th. These interesting little Rodents are also new to the Collection.

Mr. Oldfield Thomas, F.R.S., exhibited specimens of a pair of Gazelles from Palestine which had been sent by Dr. Selah Merrill, U.S. Consul at Jerusalem, to Dr. Selater, and had been passed on by the latter to the British Museum*.

The Gazelle proved to have no relationship to *Gazella dorcas*, the only species as yet recorded from Palestine, but to be nearly related to the Edmi or Atlas Gazelle (*Gazella cuvieri*), of which, although distinct, it might be considered a local representative. As no Gazelle of this type was found in the intermediate countries of Tripoli and Egypt, so that connecting links were unlikely to occur, it seemed more in accordance with modern practice to give the Palestine form a binomial rather than a trinomial name.

The Gazelle was therefore proposed to be called:—

GAZELLA MERRILLI Thos. (Text-fig. 90, p. 348.)

Gazella merrilli Thos. Abstr. P. Z. S. No. 12, p. 19, Dec. 13, 1904.

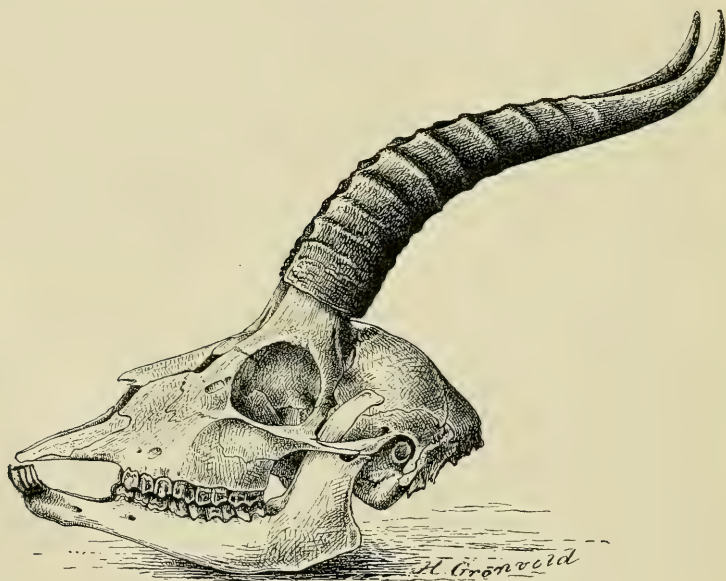
Colour and general appearance exactly as in *G. cuvieri*, the

* [The complete account of the new species described in this communication appears here, but since the name and preliminary diagnosis were published in the 'Abstract,' the species is distinguished by the name being underlined.—EDITOR.]

coarse hair, the markings, knee-brushes, and tone of body-colour all just as in that animal, of which a figure and description had been published in the 'Book of Antelopes'*.

But in size of skull and in the development of the horns the Palestine Gazelle was markedly inferior to that from the Atlas, as might be seen from the measurements given below, while the curvature of the horns was distinctly different. In *G. cuvieri* the horns, which might attain to 12 or 13 inches in height and have up to 24 well-developed rings, were very slightly curved backwards below and equally slightly—indeed scarcely at all—recurved forwards at their tips. In the Palestine form, on the other hand, the horns in an old male were short, thick basally, and markedly S-shaped, curved backwards below, and distinctly recurved forwards at their tips; the ridges, which were less well defined than in *cuvieri*, numbered only about 10–12. Viewed from in front, the horns were evenly divergent, without laryation.

Text-fig. 90.



Skull and horns of *Gazella merrilli*.

The horns of the female were of fair relative development, nearly four inches in length, and about half an inch in diameter at the base, smooth throughout, slightly curved upwards.

The skull was decidedly smaller than in *G. cuvieri*, the nasals shorter, and the premaxillary bones did not in either specimen

* Vol. iii. p. 109 (1898).

reach more than two-thirds up towards the nasals, while in *cuvieri* they articulated broadly with the latter bones. The bullae were more rounded, and the pair of prominences on the basis of the skull over the basilar suture were much more developed than in the single old skull of *G. cuvieri* available. From *G. arabica*, to which there was a certain resemblance in the set and curvature of the horns, *G. merrilli* was distinguished by its conspicuously greater size.

The typical male skull of *G. merrilli* measured as follows:—greatest length 194 mm.; basal length (c.) 170; greatest breadth 88; muzzle to orbit 99; length of upper-tooth row 60.

Horns—♂. Length over curves anteriorly 241; basal circumference 108. ♀. Length 98; basal circumference 41.

Type. ♂, B.M. No. 4.12.18.1. Killed 11th December 1903. Presented by Dr. Selah Merrill through Dr. P. L. Selater.

Hab. Hizmeh, just north of Jerusalem.

The following extract from a letter from Dr. Merrill, dated 31st October 1904, will give an idea of where this new Gazelle was found:—

“The male Gazelle was brought to me Dec. 11th, 1903, and the female on February 7th, 1904. Both were shot by a hunter whom I know, and who has served me at times during several years past. His home is at Hizmeh, five or six miles north of Jerusalem; he is a plain simple man, and probably never goes as far as ten miles from his village. Hizmeh is near Wady Farah, two hours north-east of Jerusalem. All that region for many miles north of Wady Farah, where the tableland of Judea breaks down to the Jordan valley, is very wild and has never been very carefully explored.”

Mr. Thomas had much pleasure in naming this new Gazelle, which represented a type quite new to the Palestine Fauna, in honour of its discoverer Dr. Selah Merrill.

The following papers were read:—

1. The Characters and Synonymy of the British Species of Sponges of the Genus *Leucosolenia*. By E. A. MINCHIN, University College, London.

[Received November 15, 1904.]

(Text-figures 91-98.)

I. INTRODUCTORY.

The following memoir is an attempt to fix the nomenclature and to define the characters of the British species of Ascons belonging to the section for which, in my opinion, the name *Leucosolenia* is the correct taxonomic designation. In order to

carry out this intention a large number of specimens, including the types of earlier authors, have been carefully examined. This task has been forced upon me as the result of some investigations upon the development of the various forms of spicules in sponges of the genus *Leucosolenia*, which it is hoped to publish shortly. It was found that in describing the spicule-development it would be necessary either to use names for the species which were incorrect or else to employ a nomenclature at variance with that in the current literature dealing with these sponges. And since the utmost confusion exists with regard to the designation of these species both in the labels of museums and collections, no less than in even the most recent works dealing with them, it seemed worth while trying to give a thorough description of their distinctive characters once and for all. It was my original intention to have included the Mediterranean species in this memoir, but lack of material forced me to confine myself for the present to the British forms, which, moreover, are the more important from the taxonomic point of view, as including the earliest described sponges of the genus.

The generic name *Leucosolenia* Bwk. is used by different authors in different senses, but is employed in this memoir in the same sense as in my former publications [15, 16], namely, to include those Ascons which form a natural group distinguished by the following characters:—

(1) The sponge-body or colony grows in a more or less erect form with relatively large, distinct oscular tubes. (2) All three kinds of spicules are present—monaxon, triradiate, and quadriradiate. (3) The triradiate systems have two paired angles, less than 120° , and an unpaired angle greater than 120° , corresponding to a straight median ray and two curved lateral rays. (4) The collar-cells have the nucleus apical in position, situated close under the origin of the flagellum. (5) The larva is an amphiblastula, and the first spicules formed are monaxons. Of these characters, all except (2) are family characters, distinguishing the *Leucosoleniidae* from the *Clathrinidae*; the latter having a reticulate form, equiangular triradiate systems, basal nucleus in the collar-cells, and parenchymula larva, the first spicules to be formed being triradiates. The presence of all three kinds of spicules distinguishes *Leucosolenia* from Haeckel's genus *Ascyssa*, in which monaxons alone are alleged to be present—a genus which, if it exists, should probably be placed in the family *Leucosoleniidae*.

II. HISTORICAL REVIEW AND CRITICISM.

The earliest descriptions of species of Ascons were based entirely on outward form and appearance, and though the spicules were noticed and figured no use was made of differences in spiculation in order to distinguish the species. The external characters of an Ascon are not a very safe guide, as a rule, to its specific identification. In some cases, however, a species has a typical

form which enables one to recognise it almost with certainty, or at least to distinguish it from others belonging to the same fauna by simple inspection. That is the case particularly with *Leucosolenia botryoides*, the first-named Ascon species described in 1786 from the British coast (locality Emsworth, between Sussex and Hampshire) by Ellis and Solander [7] under the name *Spongia botryoides*. In this case the form is so characteristic that there can hardly be any doubt as to the species which is represented by the authors' figure. The next species of *Leucosolenia* to be described was the *Spongia complicata* of Montagu [17], also from the British coast; and in this case it is more difficult to be positive, but, on the whole, it is highly probable that Montagu's figures represent a specimen of the sponge for which his name is retained, following Haeckel, in this memoir. The arborescent mode of growth depicted is a feature extremely characteristic, if not absolutely distinctive, of this species, at least as far as the British fauna is concerned. On the other hand, more doubt attaches to the third species described, the *Spongia confervicola* of Templeton, 1836 [22], which is evidently a *Leucosolenia* from the figures, but of which the specific identity remains doubtful. Templeton's memoir is freely annotated by "G. J.," apparently George Johnston, and the footnote to *S. confervicola* is "*Spongia complicata* G. J." I am more inclined to the opinion, however, that the figure of *S. confervicola* represents a specimen of the later described species "*Ascandra variabilis*" of Haeckel, though Haeckel himself identifies it with *botryoides*. In any case, as the point cannot be determined, *Spongia confervicola* must be regarded as a *nomen nudum* without importance for taxonomic nomenclature. Johnston, in his work of 1842 [14], ignores both *Spongia complicata*, as Fleming [8] had done before him, and *S. confervicola*; both these authors recognise only *Spongia botryoides*, and regard Montagu's *S. complicata* as merely a variety of the former.

In the meantime different authors had subdivided the comprehensive genus *Spongia* into various genera, and Templeton was one of the last to employ the name for any calcareous sponge. Fleming in 1828 [8] proposed the generic name *Grantia* for all calcareous sponges, putting *G. compressa* Fabr. as the first, and *G. botryoides* Ell. & Sol. as the second species; *compressa* must therefore be regarded as the type species of *Grantia*. Grant in 1833 [11] proposed the genus *Leuconia* for calcareous sponges, putting as his first species *nivea*, which is therefore the type species of this genus. In 1834 de Blainville [6] proposed the name *Calcispongia* in exactly the same sense as *Grantia*, putting also *compressa* first and *botryoides* second, so that this generic name becomes a synonym of *Grantia*. A great advance was made by Bowerbank [1], who, in 1864, further subdivided the calcareous sponges. Pointing out that *Grantia botryoides* was quite different from either the *G. compressa* (Fabr.) or *G. nivea* (Grant) of Fleming, he retained Fleming's genus *Grantia* for *compressa*,

Grant's genus *Leuconia* for *nivea*, and placed *botryoides* in a new genus *Leucosolenia*. In making these changes Bowerbank acted with perfect correctness, according to accepted modern rules of nomenclature; and it is clear that for the species *botryoides* the generic name *Leucosolenia* has the priority over all other generic names for it, or for other species associated with it generically. *Leucosolenia* is, in short, the first generic name put forward which has an undoubted Ascon as the type species.

Bowerbank added various species to his genus *Leucosolenia*, amongst them forms which, in my opinion, cannot be associated generically with *botryoides*, and therefore do not belong to the genus *Leucosolenia* as here understood, but to that section of the Ascons for which I employ the generic name *Clathrina* (Gray, 1867). Moreover, Bowerbank did not properly understand the distinctions between the different species which he dealt with, so that different species are found confused together in his monograph in an extraordinary manner, and his descriptions are sometimes quite incorrect. Thus the specimen described and figured as *L. botryoides* in vol. i. of his monograph (p. 164, figs. 347, 348, pl. xxvi.) does happen to be a genuine specimen of *botryoides*. This can be seen at once from his figure 348, which is extremely characteristic, and I have been able to examine this specimen and have figured its spicules (text-fig. 98, figs. 27 a-g, p. 390). On the other hand, the specimen figured as *L. botryoides*, in vol. iii. pl. iii. fig. 1, is a specimen of the species described by Haeckel under the specific name *variabilis*, and the description given by Bowerbank of the triradiate spicules as "equiangular" (vol. ii. p. 28, vol. iii. p. 7) can be seen, even from his figures, to be incorrect. Bowerbank further described a new species under the name "*Leucosolenia contorta*." I hope to discuss the rather complicated question of the characters and synonymy of this species in another memoir, the true *contorta* being a *Clathrina*. I will only say here that amongst specimens identified by Bowerbank as *contorta* I have found a *Clathrina* species mixed up with specimens of *Leucosolenia complicata* and *variabilis*. Bowerbank himself considered (vol. ii. pp. 30, 31) that his species *contorta* might be synonymous with Montagu's species *complicata*, but was more inclined to regard Montagu's figure of the latter as being "a very characteristic figure of *Spongia botryoides* Ellis & Solander," and thought it better under the circumstances to reject the term *complicata* altogether. Finally, in vol. iii. of his monograph, Bowerbank described and figured a sponge found in Brighton Aquarium under the name of *Leuconia somesii* (pp. 334-332, pl. xci. figs. 6-17). A glance at his figures makes it obvious that this sponge is a *Leucosolenia*, but his description is inadequate for determination of the species. Having been able to examine Bowerbank's types of this species in the British Museum, I found them to be merely aberrant specimens of *Leucosolenia variabilis* (Haeckel), as Topsent had already suspected, characterised by the great development in the number and length of

the monaxons, and, as shown by Bowerbank's figures, a great tendency to the production of abnormal forms of triradiates (see text-fig. 95, figg. 18 *a-e* and 19 *a-h*, p. 379). *Leuconia somesii* may, in short, be characterised as an interesting aquarium variety of *Leucosolenia variabilis*, showing modifications parallel to those described by Bidder for *Sycon raphanus**, growing in the Naples Aquarium. Bowerbank himself was struck by the resemblance of this sponge to a *Leucosolenia*, and particularly to the specimen figured by him in pl. iii. fig. 1, which, as stated above, was actually a specimen of *L. variabilis*; he remarks that the only other known British calcareous sponge with which this species is likely to be confounded is *Leucosolenia botryoides*, but "only in its young and immature state." *Leuconia somesii* must therefore be put as a synonym of Haeckel's species *variabilis*.

Enough has been said to justify the criticism made above that Bowerbank did not grasp the real distinctions between the species of his genus *Leucosolenia*†. It is the great merit of Haeckel, whose name marks the next epoch‡ in our knowledge of calcareous sponges, that he was the first to understand the great importance of the spicules in specific determinations, and to give descriptions of the species by which they could be recognised clearly. It may be said, in short, that previous to Haeckel's great monograph no species of calcareous sponge was really adequately characterised, and that Haeckel was the first to show how this should be done. Hence, where previous descriptions of a calcareous sponge leave us in doubt as to its identity, *Haeckel's determination of its characters fixes the application of the name*.

Had Haeckel carried out his own method with accuracy and conscientiousness it would not have been necessary for the present paper to be written, but unfortunately this is far from being the case. Of the specimens which I have been able to examine, some have been through Haeckel's hands and have been identified by him, and these show, in many cases, the most extraordinary errors of identification, as will be evident from the descriptions and figures given below. It will be made clear, also, that in two cases at least he founded unnecessary species simply as the result of overlooking spicules in certain specimens which he found to be present in others of the same species. Haeckel's numerous species of Ascons require, one and all, a thorough re-examination, and there can be no doubt that a careful revision would result in

* Quart. Journ. Micr. Sci. v. xxxviii. p. 10.

† To the well-known monographs of Oscar Schmidt [19, 20], more or less contemporary with Bowerbank's writings, further reference is not necessary here, since of *Leucosolenia*, in the sense used in the present memoir, only two species are described, *L. tieberkühnii*, which is not a British form, and *L. fabricii*, which appears to be a synonym of *complicata*.

‡ Both of Haeckel's works, the 'Prodromus' (1870) and the 'Monographie' (1872), were published at dates between those of the second and third volumes of Bowerbank's 'British Spongiadae'; but they were not noticed by Bowerbank, and belong in all respects to a subsequent epoch. Of Bowerbank's species, only *Leuconia somesii* was described after Haeckel's monograph, and is therefore not noticed by the latter.

many, perhaps the majority, of his specific names becoming synonyms.

There is, however, a further blemish on Haeckel's work, which has been the cause of all the universal confusion in the nomenclature of these sponges. Haeckel took no notice in his final monograph* of any generic names for calcareous sponges used before him. Making a clean sweep of all previous names, he set up twenty-one new genera, seven of which were Ascons. Such a proceeding could not, of course, be tolerated, being a flagrant violation of the rules of taxonomic nomenclature which have long been followed in this country, and now are universally accepted abroad also. Hence Haeckel's system has undergone various modifications at the hands of subsequent writers.

The first work of primary importance dealing with calcareous sponges after Haeckel was Poléjaeff [18], who reverted to Bowerbank's use of the name *Leucosolenia* to denote all Ascons. In works of later date some systematists have followed Poléjaeff in the use of the name *Leucosolenia*, as, for example, Topsent; others have used modifications of Haeckel's system, as, for example, Lendenfeld; and others, again, have used *Leucosolenia* in some special sense, as, for example, Breiffuss. In 1896 [15] I put forward a scheme of classification for Ascons which has not been followed by subsequent writers, but to which I still adhere. It would be foreign to the purpose of the present memoir to discuss the classification of Ascons generally, but in order to justify my use of the name *Leucosolenia* I put forward three propositions:—

(1) That the oldest Ascon genus, *Leucosolenia* Bowerbank, is a valid genus, founded in a perfectly correct manner, its type species being *L. botryoides*, the oldest described species of Ascon.

(2) That therefore the generic name *Leucosolenia* has priority over all others for this species, and the combination *Leucosolenia botryoides* is one that should never be disturbed.

(3) That therefore in any scheme of classification in which other Ascons are placed in the same genus as *botryoides*, they also should be termed *Leucosolenia*.

If these three propositions are accepted, it becomes of extreme importance to describe accurately the specific characters of *Leucosolenia botryoides*. I think I may claim to have done so in the present paper, and from the description below it will be immediately apparent that the restriction of the name *Leucosolenia* to Ascons without monaxon spicules, as done by Breiffuss, is an error, caused by Haeckel's incorrect description of the species *botryoides*.

As regards the specific determination of Ascons, the chief criticism which I have to make, with regard both to Haeckel and to post-Haeckelian systematists generally, is that sufficient account is not taken in their descriptions of the great variability of the

* In Haeckel's 'Prodromus' [12] he put forward a scheme of classification in which previous generic names were used, but in his 'Monographie' [13] he completely altered both his classification and his nomenclature.

spicules, not only in different specimens but even in any given specimen. In order to separate the essential from the accidental in the description of an Ascon, not only should many specimens be studied, if possible, but in each specimen all possible forms of spicules should be drawn. One instance from Haeckel's monograph will suffice to illustrate this point. Under the genus *Ascandra* (t. c. p. 81) the species *botrys*, which I have shown below to be a synonym of *botryoides*, is characterised as having "triradiates obtuse-angled, rays 8 times as long as thick," while the species *nitida* is distinguished from it by having "triradiates right-angled, rays 4 times as long as thick." Now if the reader will turn to my figures of the spicules of *botryoides* given below (text-figs. 97 & 98, pp. 388, 390), or, better still, will examine a specimen for himself, and compare the spicules with Haeckel's figures of the triradiates of *botrys* and *nitida**, it will be found that in *any specimen* the triradiates vary in slenderness from the types figured by Haeckel for *botrys* to those given for *nitida*, and that their paired angles vary from obtuse, in the more slender spicules, to right angles in the thicker forms. There is therefore *no argument to be drawn from Haeckel's descriptions and figures* against putting these species together and considering *botrys* and *nitida* as synonyms of *botryoides*. Whether they are really distinct or not can only be determined by fresh investigation of the specimens. Until that has been done we are justified in striking out two of the three names.

Another point in which variation occurs commonly is the relative frequency of a given type of spicule in different specimens. Thus in some specimens a form of spicule may be abundant, which in others may be so scarce that much searching may be necessary to find it†. As negative characters require much greater caution to affirm than positive ones, it is only after very careful investigation that one should declare a type of spicule to be absent in any specimen which agrees in all other respects with other specimens in which it is present; even then it would be most unsafe to separate such a specimen as a distinct species on this character alone. Yet it is in this way that Haeckel separated (in error, as it has proved) the species *botryoides* and *complicata* from their synonyms *botrys* and *pinus*.

The extreme uncertainty and doubt which attach to all identifications of Ascon-species in works dealing with them, have, it may be pointed out, one important consequence: that, namely, of rendering utterly worthless all statements concerning their geographical distribution. It is, indeed, my firm conviction that the study of the distribution of Ascons, perhaps of all Calcarea, requires to be commenced *de novo*, and to be preceded by an accurate study of their specific characters. Until it is possible to have

* The extremely fanciful, if artistic, curves which Haeckel introduces into his drawings of spicules must be discounted in making comparisons.

† Compare the very important observations of Topsent (Arch. Zool. Exp. (3) viii. p. 43) on the different types of spiculation in *Cliona celata* at different ages.

confidence in the correctness of the identification of a species, statements as to its occurrence and distribution are of no value whatever.

III. METHODS AND MATERIAL.

The present investigation has been directed mainly towards a thorough examination of the spiculation. For making preparations of calcareous spicules, the reagent used by me is Eau de Javelle. The piece of sponge selected is first of all, in the case of spirit-specimens, placed in water for a minute or two, and then put into a test-tube with a small quantity of Eau de Javelle, barely more than enough to cover the bit of sponge. In a few minutes the soft parts are dissolved, and with gentle shaking the sponge disappears, being resolved into a cloud of spicules. No heating is necessary, but the Eau de Javelle loses its powers after a few months, and should have been recently made up. The test-tube is then filled up with distilled water, shaken up well, and put aside to stand undisturbed until the spicules have fallen to the bottom, which they do in the course of a few hours. As much as possible of the liquid is then decanted off, care being taken not to disturb the spicules settled at the bottom, after which the test-tube is again filled up with distilled water, shaken up, and left to settle again. After a third washing with distilled water in this way, the Eau de Javelle is sufficiently removed, and the tube is then filled up with strong alcohol (90 per cent.), in which spicules settle much more quickly than in water*. After two washings with alcohol, the spicules are ready to be mounted. This is done simply by drawing them up with a pipette from the bottom of the alcohol in the test-tube, placing them on a slide, and burning off the alcohol, leaving the spicules dry on the slide. A drop of Canada balsam is then put on them, and on that a cover-slip. In this way very clean preparations of the spicules can be obtained. It is advisable, however, not to defer the examination of them too long, as even in Canada balsam they become corroded sooner or later, and in some samples of the mounting medium the corrosion proceeds rapidly. Hence attention should be paid to the purity, that is to say the non-acidity, of the Canada balsam employed.

For drawing the spicules I have used in all cases a camera lucida with Zeiss's ocular II. and objective D, giving a magnification of 320 (reduced in the illustrations in this memoir to 300). My method is first to draw the commoner forms of spicules seen, and then to hunt carefully through the slide and draw every spicule found differing at all markedly from those already drawn. The process is a tedious one, and it is too tiring to attempt the examination of more than two specimens a day at the utmost. But only in this way is it possible to frame an idea of the great

* The process of washing the spicule can be greatly hastened by using a centrifugal machine, but as there is great danger of their then becoming caked through interlocking of the spicule-rays, I have preferred the slower and surer method described above.

range of variations shown by the spicules in every specimen. It is, moreover, extremely easy to overlook inconspicuous forms of spicules. It was not until I had studied carefully many specimens of *botryoides* and *variabilis* that I became aware of the invariable presence in both of slender straight barbed monaxons (text-fig. 94, fig. 10 *k*, *l*, p. 377; text-fig. 97, fig. 22 *l*, *u*, &c., p. 388).

For the study of the species dealt with in the present memoir I have examined specimens from various sources. Besides those which I have collected myself at Plymouth, Roscoff, and elsewhere, or which have been sent me by friends, I have had access to specimens of historic importance in the private collection of Canon A. M. Norman, and in the collections of the British Museum and the Berlin Museum. Among those who have given me specimens my thanks are especially due to Mr. Walter Garstang, who sent me numerous specimens from the neighbourhood of Plymouth, and Monsieur E. Topsent, who sent me specimens from France. Canon Norman, with great liberality, placed his collection at my disposal and allowed me to examine all his specimens*. The information I acquired in this way was most valuable, since his collection comprised type specimens of Bowerbank and others, as well as many which had been through Haeckel's hands, identified by him, and returned with the labels written or endorsed by Haeckel with his own hand. Not less valuable, and more numerous, were the specimens in the British Museum of Natural History, for access to which I have to thank Dr. A. C. L. Günther, F.R.S., who permitted me to examine all the specimens, and Mr. Kirkpatrick, who most kindly looked them out for me and instructed me as to the various handwritings on the labels. For examination of the specimens in the Berlin Museum I am indebted to Dr. Weltner, who, by the kind permission of Professor Moebius, was so good as to send me small pieces of the Ascons in the Berlin collection, to enable me to study their spiculation.

A list of the specimens from various sources which I have thus been able to examine is given below, following the descriptions of the species, from which it will be seen that my identification of a specimen is often very different from that of its previous label. I have only to add that, in the case of each specimen mentioned, the spicules have been carefully drawn by me with the aid of the camera lucida in the manner described above. The illustrations to this memoir are tracings from a selection of the drawings so made.

IV. GENERAL REMARKS ON THE CHARACTERS OF THE SPECIES OF *LEUCOSOLENIA*.

The external form and mode of growth in the genus *Leucosolenia*

* It is now ten years since I examined Canon Norman's specimens, and nearly as long since I obtained for study the specimens from the British and Berlin Museums. Much stress of other work has prevented the completion of these investigations.

are subject to considerable variations, due to the particular environment and conditions under which the sponge grows in each case. The variability of form is, however, combined always with constant and characteristic features, and may be compared with the different forms which a creeping plant will assume under different natural conditions. Too much has been made, in many works, of this variability, and not enough of the constancy which underlies it. No one who has a working acquaintance with Ascons can ever mistake a *Leucosolenia* for a *Clathrina*, except perhaps in the very youngest stages of growth; there is no need for me to repeat here what I have said in previous memoirs as to the diagnostic importance of the form of the sponge for distinguishing the two genera. It is, moreover, by no means difficult, indeed it is usually very easy, to recognise at sight all the species occurring in any particular locality, when one has once become intimate with their characteristic features. Yet from looking at Haeckel's plates of these sponges, the impression gained is that Ascons have no characteristic generic or specific features except in the spiculation. Haeckel's artistic pencil has misled him, and others, upon this point, and his plates fail to portray the natural appearance of the sponges.

Speaking generally, there are three principal types of body-form occurring in the species of *Leucosolenia*. If the sponge be growing on a bare rock, or on the stem of a large alga, it will creep over it, sending out anastomosing basal stolons from which oscular tubes arise at intervals. Such a specimen has been figured by me elsewhere [16, fig. 5]; it was found growing over a granite rock at Roscoff, and is now in the British Museum. This type of colony may be designated the *spreading* form; it is not at all common, since it may be supposed to be a rare occurrence for the sponge to find a rock-surface unoccupied by other competitors. More usually these sponges are found growing crowded up amongst algæ and various organisms, often in muddy situations, or creeping over the seaweeds, and they then assume a form which may be termed *bushy*; an example of this mode of growth has been figured by me in the case of a specimen of *L. lieberkühnii* [l. c. fig. 3] which came from the keel of a ship moored permanently in the Porto Militare at Naples, and which was growing in a luxurious forest of algæ, hydroids, barnacles, worm-tubes, &c. The bushy form is the commonest type of *Leucosolenia*-colony. In a third modification the sponge forms a creeping or *arborescent* growth usually closely applied to its support, but sometimes branching out under favourable circumstances into tree-like growths [l. c. fig. 4]. Although all these three modifications of form merge into one another, it is convenient to classify them into the three principal types noted above.

A few words upon the characters of the spicules will not be out of place here. The three kinds of spicules found in *Leucosolenia* may be classified into: (1) monaxon spicules, simple needle-like forms; (2) triradiate systems, with or without the addition of a

fourth or gastral ray. In the monaxons a proximal end imbedded in the wall of the sponge is to be distinguished from a distal end projecting freely into the water. The shaft of the monaxon is generally thickest towards the proximal end, at which it tapers rapidly to a blunt or moderately sharp point. The distal end usually has a barb or "lance-head," frequently rudimentary or absent. The barb is in reality a double bend in the axis of the spicule, and is comparable to a very thick bayonet, rather than to a spear-head*. In cases where it is absent, the distal ends of the monaxons become excessively sharp and fine.

A remarkable point with reference to the monaxons of *Leucosolenia*, which I have found to hold good, not only with regard to the species described in this memoir, but also for all other species that I have examined, is that the monaxons can be separated more or less easily into two varieties, distinguished by the fact that one kind appears very refringent, the other, by comparison, pale, under the microscope. The refringent monaxons are always scarcer than the pale ones, but their peculiar optical property makes it very easy to find them, especially under low powers (Zeiss, Oc II. Obj. B). In form the two kinds of monaxons may not differ essentially, but the refringent ones always show certain characteristics which may be summed up by saying that they tend to be straighter, more slender, and sharper than the others, and their distal barb is less distinct or absent. When examined by means of polarised light, the conditions are reversed, since the pale monaxons light up brightly between crossed prisms, while the refringent forms remain dark or feebly illuminated. This is particularly well seen in the small monaxons of *L. variabilis* (see below, p. 380), where the curved forms light up most brilliantly with crossed prisms, while the straight refringent forms remain quite dark or only slightly illuminated in all positions, when the stage of the microscope is rotated. This shows clearly that the difference between the two types is due to a difference in the relation of the axis of crystallisation to the form of the spicule.

The triradiate systems which do not acquire gastral rays do not differ in any other structural feature from those which, by doing so, become quadriradiates. In some cases the triradiates and quadriradiates may differ in size, and their relative abundance varies greatly in different specimens. In each triradiate system we have to distinguish, as has been said above, an unpaired or posterior ray, which in the oscular tube points away from the oscular opening, and two paired lateral rays; the latter make with the posterior ray paired lateral angles less than 120° and sometimes almost approaching 90° ; the lateral rays at their junction enclose an unpaired anterior angle, which is greater than 120° in proportion as the lateral angles are less. The lateral rays are nearly always distinctly curved; the posterior ray is normally straight.

* This point is, unfortunately, not very well brought out in the drawings accompanying this memoir.

Since the triradiate systems lie in the wall of a hollow cylinder, the three rays are never in the same plane, but are disposed in such a manner that if the spicule be viewed in a direction corresponding to the axis of the unpaired ray, the two lateral rays appear to meet at an angle less than 180° on the gastral side, greater than 180° on the dermal side. This is an important fact to bear in mind when studying the spicules in preparations. If the spicule be lying on the slide with its dermal face uppermost, then the points of the three rays touch the slide, but their junction is raised off it; hence the spicule appears from this aspect perfectly symmetrical, with two lateral rays of equal length and similar curvature, but each of the three rays is slightly foreshortened. If, on the other hand, the spicule be lying on the slide with its gastral face uppermost it may lie so as to appear symmetrical, but more usually it is found lying with one lateral ray and the posterior ray flat on the slide, the other lateral ray pointing obliquely upwards. Hence when the two rays which lie flat are in focus the third ray is out of focus, and when drawn with the camera it appears foreshortened, giving the spicule an asymmetrical appearance. To this fact is due the foreshortened appearance of one of the two lateral spicule-rays in many of my drawings, especially of *L. botryoides*, in which the thickened T-shaped triradiate systems are very concave on the gastral face.

V. DESCRIPTION OF THE SPECIES.

1. LEUCOSOLENIA COMPLICATA.

Spongia complicata Montagu, 1812, Wernerian Memoirs, ii. p. 97, pl. ix. figg. 2, 3.

Spongia botryoides pars Grant, 1826, Edinb. New Phil. Journ. i. p. 169.

Grantia botryoides pars Fleming, 1828, Hist. Brit. Animals, p. 525.

Grantia botryoides pars Johnston, 1842, Brit. Spong. and Lithophytes, p. 178.

Leucosolenia contorta pars Bowerbank, 1866, Mon. Brit. Spong. ii. p. 9; 1874, iii. pl. iii. figg. 5-10.

Leucosolenia botryoides Gray, 1867, P. Z. S. p. 555.

Leucosolenia fabricii O. Schmidt, 1869, Mitth. naturwiss. Ver. Steiermark, ii. p. 91.

Leucosolenia fabricii O. Schmidt, 1870, Grundz. Spong.-Faun. Atl. Geb. p. 73.

Olynthus hispidus Haeckel, 1870, Jena. Zeitschr. v. p. 237.

Olynthus pocillum Haeckel, 1870, l. c. p. 237.

Leucosolenia amaboides Haeckel, 1870, l. c. p. 243.

Leucosolenia (Leucelia) complicata Haeckel, 1870, l. c. p. 243.

Leucosolenia fabricii Haeckel, 1870, l. c. p. 243.

Asculmis seu *Ascandra armata* Haeckel, 1872, Kalkschw. pp. 77-79, pl. 13.

Ascortis seu *Ascandra fabricii* Haeckel, 1872, l. c. p. 71, pl. 11. fig. 3, pl. 12. figg. 3 a-3 i.

Ascandra complicata Haeckel, 1872, l. c. p. 93, pl. 15. figg. 1 a-1 k.

Ascandra pinus Haeckel, 1872, l. c. p. 105, pl. 16. figg. 3 a-3 i and pl. 19.

? *Ascandra contorta* Barrois, 1876, Embryol. d. q. Éponges d. l. Manche, Ann. Sci. Nat. (6) iii. p. 36.

Ascandra complicata Bowerbank and Norman, 1882, Mon. Brit. Spong. iv. p. 226.

Ascandra complicata Fristedt, 1887, 'Vega' Exped., Vetenskapl. Iakttagelser, iv. p. 406.

Leucosolenia pinus Topsent, 1891, Arch. Zool. Exp. (2) ix. p. 525.

Leucosolenia complicata Levinsen, 1893, Vid. Ud. Kanonbaaden 'Hauchs' Togter, v. p. 424.

Leucosolenia complicata Weltner, 1894, Wissensch. Meeresuntersuch. n. F. i. p. 325.

Leucosolenia complicata Minchin, 1896, Ann. Mag. Nat. Hist. (6) xviii. p. 359.

Leucosolenia complicata Bidder, 1898, P. R. Soc. lxiv. p. 69.

Ascandra complicata Breitfuss, 1898, Arch. Naturges. lxiii. i. p. 213.

Ascandra contorta Breitfuss, 1898, l. c. p. 214.

Ascandra fabricii Breitfuss, 1898, l. c. p. 214.

Ascandra fabricii Breitfuss, 1898, Mém. Acad. St. Pétersbourg, (8) vi. p. 7.

Ascandra contorta Breitfuss, 1898, l. c. p. 15, pl. i. fig. 1.

Ascandra fabricii Breitfuss, 1898, Arch. Naturges. lxiv. i. p. 285.

Ascandra contorta Breitfuss, 1898, l. c. p. 285.

Ascandra complicata Breitfuss, 1898, l. c. p. 285.

Ascandra fabricii Breitfuss, 1898, Ann. Mus. Zool. Acad. St. Pétersbourg, p. 17.

Ascandra complicata Breitfuss, 1898, l. c. p. 27.

Ascandra contorta Breitfuss, 1898, l. c. p. 27.

Leucosolenia complicata Minchin, 1900, in Lankester's Treatise on Zoology, ii. Sponges, p. 5, fig. 5.

Ascandra complicata Arnesen, 1901, Bergens Mus. Aarborg, 1900, no. 5, p. 13.

Ascandra armata Arnesen, 1901, l. c. p. 13.

Leucosolenia complicata Rousseau, 1903, Mém. Soc. Malac. Belgique, xxxvii. p. 7, fig. 3.

Leucosolenia fabricii Rousseau, 1903, l. c. p. 6, fig. 2.

Leucosolenia complicata Allen, 1904, J. Mar. Biol. Assoc. n. s. vii. p. 185.

I commence with this species as being the most easily identified of the three British *Leucosolenias*, although, curiously enough, it is more often found incorrectly determined than either of the others. While the systematists previous to Haeckel for the most part considered it a synonym of *botryoides*, recent authors have

generally confused it with *Clathrina contorta*, impossible as this might seem to anyone acquainted with the two species, and considering not only the sharp differences in spiculation, correctly described by Haeckel, but also the complete dissimilarity in external form and appearance between the two sponges; nothing could be imagined, in fact, more unlike than full-grown colonies of the two sponge species.

(a) *External Characters.*

Leucosolenia complicata occurs commonly in either the bushy or the arborescent form. My specimens from Plymouth are all of the former type; I have it not only from rock-pools along the shore, but also dredged from deep water off the Mewstone. This delicate sponge is rarely found in situations in which it is liable to be left dry at low tide. It forms compact colonies in which numerous closely-set oscular tubes arise from, and partly conceal, a basal growth of finer tubes forming a reticulum attaching it to the substratum. In my specimen from the Mewstone the oscular tubes show a marked tendency to assume the characteristic tree-like form, especially towards the centre of the bushy colony.

The largest specimens of *L. complicata* that I have seen were collected in the *Zostera*-beds at Roscoff, close to the Laboratory, where this beautiful sponge, favoured by the shelter afforded, grows in profusion and in the most luxuriant manner. As a rule, it does not grow on the *Zostera* itself but on the stronger and tougher algæ found associated with it. The sponge itself is so fragile that it is scarcely possible even to lift a large specimen out of the water without pieces breaking off, and I have found it impossible to transport them entire. These specimens, and all others which I have collected at Roscoff, show the typical arborescent form by which the sponge can be recognised at a glance, a mode of growth perhaps correlated with the clean granite rocks and sand, and the pure water, very free from mud and sediment, at Roscoff, while in Plymouth Sound the conditions are more estuarine. In the largest specimens from the Roscoff *Zostera*-beds the arborescent growth differs, in a manner which strikes the eye at once, in different portions of the sponge-colony. In the deeper parts, close to the stems of the supporting seaweed, the oscular tubes form a looser, more straggling growth, apparently due to the fact that they grow more rapidly in length than do the diverticula which arise from them. Higher up the oscular tubes are found growing vertically upwards, and at the same time sending out on all sides a profusion of diverticula which become oscular tubes and throw out other diverticula in their turn, with the result that the sponge assumes the pinetree-like form figured and described by Haeckel from the coast of Normandy under the name *Ascandra pinus* (Monographie, vol. ii. p. 105, vol. iii. pl. 19). Haeckel's figure represents this form fairly well, except that, as usual, he puts more curves into the branches than they should

have. The straightness of the oscular tubes is rather a marked feature of the "*pinus*" form. Where Haeckel's figure is most in error is in representing this tree-like form as an independent growth arising by a massive trunk from a solid rock-foundation, instead of being merely the upper part of a large colony. It is these pinetree-like portions which generally drop off by their own weight when the sponge is gathered, or become detached during transport of the specimen, and it was doubtless to a fragment of this kind that Haeckel's sense of artistic completeness supplied the lacking foundation. I have also found *L. complicata* at Roscoff growing amongst the stems of algae on rocks and isolated boulders, in situations where it is left dry at the spring-tides, though not at ordinary tides. Under these conditions also the sponge shows the characteristic arborescent growth, but clings close to the seaweeds and is never independent of them to any great extent*.

Comparing different specimens of this sponge, I find that the most constant feature of its habit of growth is, that the erect and often very long oscular tubes never grow to any length without throwing out diverticula, which, in their turn, give rise to other diverticula and soon form oscula at their distal extremity. Hence the oscular tubes of *L. complicata* are always beset with diverticula to a greater or less extent, thus contrasting with the long, smooth, usually slender oscular tubes characteristic of *L. variabilis*. The body-wall is usually thinner and more delicate than in *variabilis*, and the natural contour is a pure creamy white, except when obscured by sediment and the numerous diatoms and other organisms which settle on the exterior of the sponge.

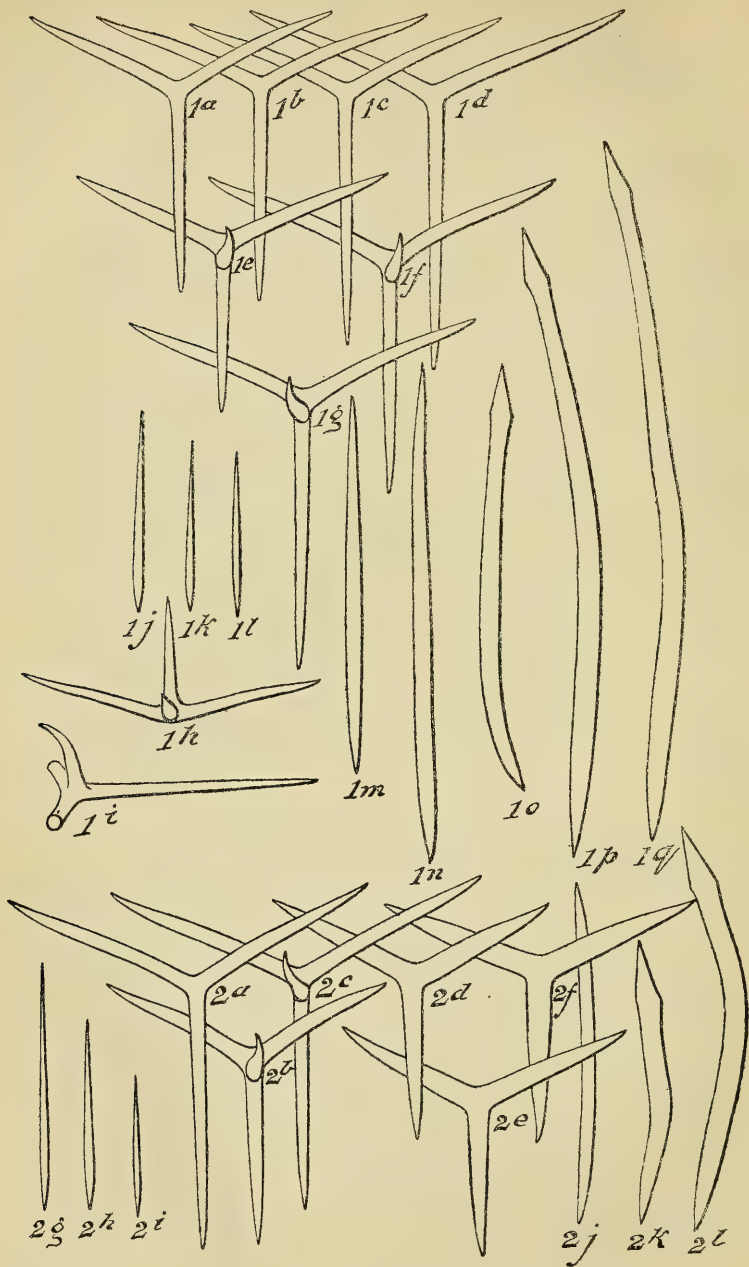
Another distinctive feature of this sponge is the shortness of the oscular rim—that is to say, of that portion of the oscular tube immediately surrounding the oscular opening which is not lined by collar-cells.

(b) Characters of the Spiculation.

(a) *Triradiate and Quadriradiate Systems*.—(1) The ordinary triradiates, such as are found in every specimen (text-fig. 91, fig. 1 *a-d*, &c., p. 364), have the rays slender and tapering gradually to sharp points. The unpaired ray is straight and distinctly longer than the paired rays, or at least equal to them in length; the exceptions to this rule are so rare that they may be termed abnormalities. The paired rays show a more or less distinct double curvature; proximally they slope very slightly backwards for about two-thirds of their length, while at their distal extremity they curve forwards rather more sharply. The unpaired angle is only slightly greater than 120° ; so that the system often appears nearly equiangular, but is never quite so. The usual length of the unpaired ray is

* I am informed that *Zostera*-beds similar to those at Roscoff occur also at Jersey, and it is probable that from them come the specimens of this sponge sent out by Hornell's Zoological Station, and found in various collections with the label *Leucosolenia contorta*.

Text-fig. 91.



from $100\ \mu$ to $120\ \mu$, the thickness about $6\ \mu$; the paired rays range from $75\ \mu$ to $90\ \mu$ in length, with a thickness of about $7\ \mu$. (2) Besides the ordinary triradiates just described, there occur in some specimens triradiates with shorter and more thickened rays (text-fig. 91, fig. 2 *d-f*, p. 364; text-fig. 93, fig. 7 *c*, p. 369). The proximal curve of the paired rays is scarcely noticeable; while the distal curve is rather accentuated. The length of the rays is about $70\ \mu$ or rather more in some specimens, the thickness 9 or $10\ \mu$. (3) The ordinary quadriradiates have the basal rays similar to (1) and the gastral rays of moderate length, curving forwards at the tip, smooth and tapering evenly to a point (fig. 1 *i*). The gastral ray is implanted on the unpaired ray of the basal system, distinctly behind the central point of the junction of the three rays composing it. In some specimens the quadriradiates are, on the average, of slightly larger dimensions than the triradiates. (4) Occasionally a gastral ray is found developed on the thickened triradiates (2), but this is rather a rare type of spicule (text-fig. 93, fig. 7 *e*, p. 369).

(b) *Monaxon Spicules*.—Three kinds occur constantly, and are the most diagnostic feature of the species. (1) Large spicules with distinct lance-heads (text-fig. 91, figg. 1 *o-q*, p. 364). The cylindrical shaft is always more or less curved, sometimes irregularly, and tapers rather rapidly to a sharp point at the proximal extremity, but at the distal end remains of even thickness or diminishes only very slightly and almost imperceptibly up to the large, broad, sharp-pointed lance-head. The length is usually from 190 to $280\ \mu$, the thickness 9 or $10\ \mu$. (2) Large spicules without lance-heads, belonging to the category of refringent monaxons (text-fig. 91, figg. 1 *m*, 1 *n*, p. 364). These are generally fewer in number than (1), and each is usually nearly straight or but slightly curved. The shaft is thickest about one-fourth of its length from the proximal end, whence it tapers rapidly to a point proximally and very gradually to a sharp point distally. Sometimes there is a slight indication of a rudimentary lance-head distally, but usually there is none. Length usually about $200\ \mu$, greatest thickness 8 or $9\ \mu$. (3) Small and slender spicules, usually with no trace of a lance-head, and, with rare exceptions, perfectly straight (text-fig. 91, figg. 1 *j* to 1 *l*, &c.). The shaft is thickest close to the proximal end, where it tapers rapidly to a point. From the region of greatest thickness the shaft tapers extremely gradually to the very sharp

Explanation of Text-fig. 91 (opposite).

Spicules of *Leucosolenia complicata*.

Figg. 1 *a-l q*. Spicules of a quite normal specimen from Roscoff, one of the same lot as that figured in Lankester's 'Treatise on Zoology,' part ii. Porifera, p. 5, fig. 4. *a-d*, triradiates; *e-i*, quadriradiates; *j-l*, slender monaxons; *m*, *n*, large monaxons without lance-heads; *o-q*, large monaxons with lance-heads.—Figg. 2 *a-2 l*. Specimen dredged on Duke Rock, Plymouth (Garstang), showing thickened triradiates in addition to ordinary forms. *a*, ordinary triradiates; *b* & *c*, quadriradiates; *d-f*, thick triradiates; *g-i*, slender monaxons; *j*, large monaxon without barb; *k* & *l*, large barbed monaxons.

distal extremity, which in some specimens shows slight indications of a lance-head, but more usually does not. These spicules are, as a rule, short, from 70 to 140 μ in length, the greatest thickness about 3 μ ; but they are subject to extraordinary variations in length, which are described in more detail below.

Variations of the Spiculation.—(1) *As regards the relative number of the spicules.* In some specimens no examples of the thickened triradiates (*a*, 2) are to be found, or only after much searching; in others, on the other hand, they are relatively abundant (text-fig. 91, figg. 2 *d-f*, p. 364), and by their presence give a distinct facies to the general spiculation, which might lead at first sight to the impression that the specimen represented a distinct species or variety. The relative numbers of triradiates and quadriradiates are also subject to great variation.

The large barbed monaxons are always abundant, and constitute a marked feature of the species. Even more characteristic are the small slender monaxons (*b*, 3), which are usually very abundant; but in some specimens they are relatively scarce, and require to be searched for carefully. They are also very liable to be broken, by reason of their slender proportions. As pointed out below, through Haeckel having overlooked the monaxons in some specimens, he was led to make two species, *pinus* and *complicata*, characterised by their presence and absence respectively. I have never, however, found the small monaxons entirely absent in any specimen I have examined, not even in the specimen identified by Haeckel himself as *complicata* (text-fig. 92, figg. 3 *a-3 m*, p. 367). The large unbarbed monaxons (*b*, 2) are usually much less abundant than the other two kinds, but can always, in my experience, be found.

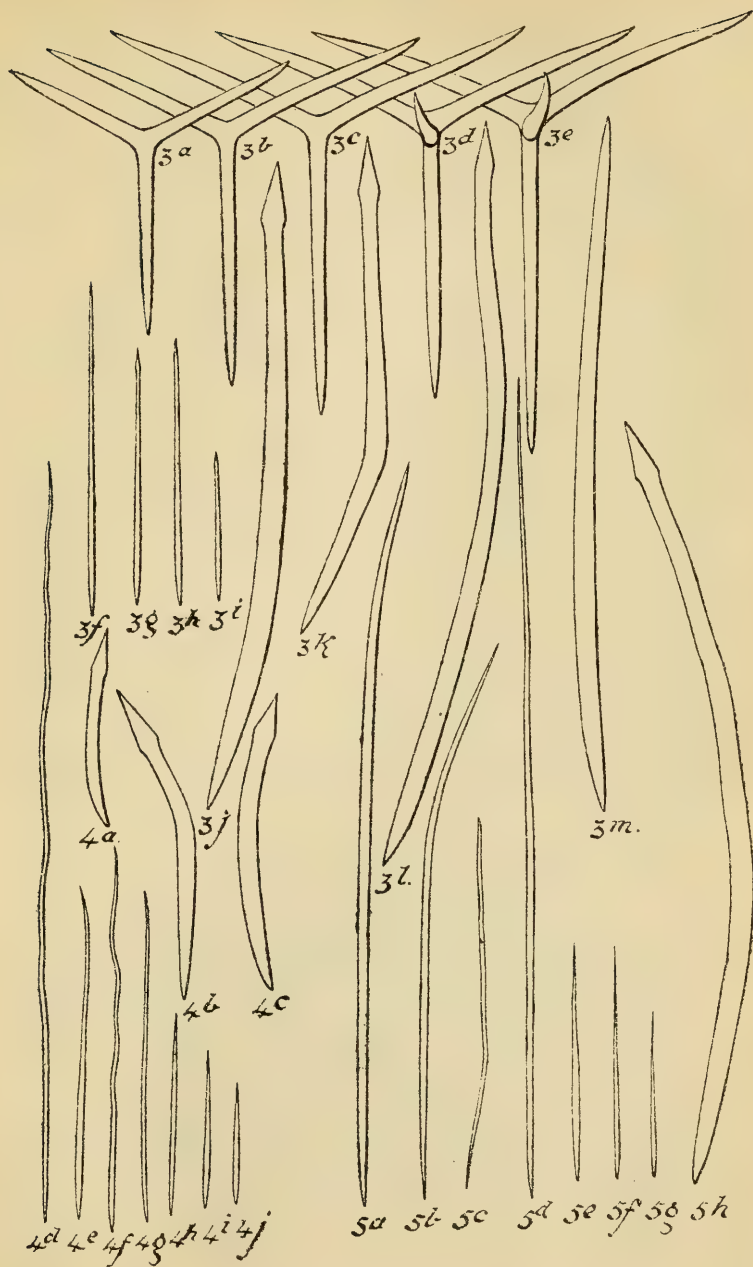
(2) *As regards the form and size of the spicules.* The triradiate systems vary considerably, both in length and thickness of the rays. Any specimen shows a considerable range of variations in this respect; but in some specimens the spicules show a tendency to be constantly smaller, in others again constantly larger. The greatest extremes of variation that have come under my notice, as regards length of the rays, are shown by the specimens Nos. 3 and 9 of my list given below. In the former, which was a very small

Explanation of Text-fig. 92 (opposite).

Spicules of *Leucosolenia complicata*.

Figg. 3 *a-3 m*. Specimen from Scarborough in Canon Norman's collection, identified by Haeckel as *Ascandra complicata*. *a-c*, triradiates; *d & e*, quadriradiates; *f-i*, slender monaxons (absent according to Haeckel), showing distinct traces of barbed heads; *j-l*, large barbed monaxons; *m*, large monaxon without barb.—Figg. 4 *a-4 j*. Specimen from North Harbour, Peterhead Beach (British Museum, Bowerbank Collection, No. 987), showing the remarkable length reached by some of the slender monaxons (*d-j*) and the small size and relative slenderness of the large barbed monaxons (*a-c*).—Figg. 5 *a-5 h*. Monaxon spicules of a specimen from the British Museum (Reg. No. 15.1.9.32-34), showing the manner in which some of the slender monaxons (*a-d*) are not only of great length but of unusual thickness and curvature. Other monaxons of the slender type are quite normal (*e-g*). *h*, one of the large barbed monaxons.

Text-fig. 92.



colony, the unpaired rays vary from 70–90 μ , the paired rays from 65–80 μ in length (text-fig. 93, figg. 6 *a*–6 *h*, p. 369). In the latter (text-fig. 93, figg. 8 *a*–8 *f*, p. 369) the unpaired rays vary from 120–170 μ , the paired from 105–125 μ . With the increased size the rays also tend to increase in thickness, reaching 10 μ or slightly over in their thickest part. This is especially well seen in a specimen sent me by Topsent from Banyuls-sur-Mer, which is remarkable for the general thickness of its triradiates (text-fig. 93, figg. 9 *a*–9 *d*, p. 369). It is interesting to note that it is in those two specimens with exceptionally large triradiates that I found barbed monaxons of the largest size, reaching a length of 425 μ in No. 9 and 360 μ in Topsent's specimen, while in No. 3 these spicules were below the average in length (150–200 μ); the small monaxons, on the other hand, did not show any noteworthy variation in those three specimens. Topsent's specimen possesses further interest as being the only example of this sponge which I have seen from the Mediterranean.

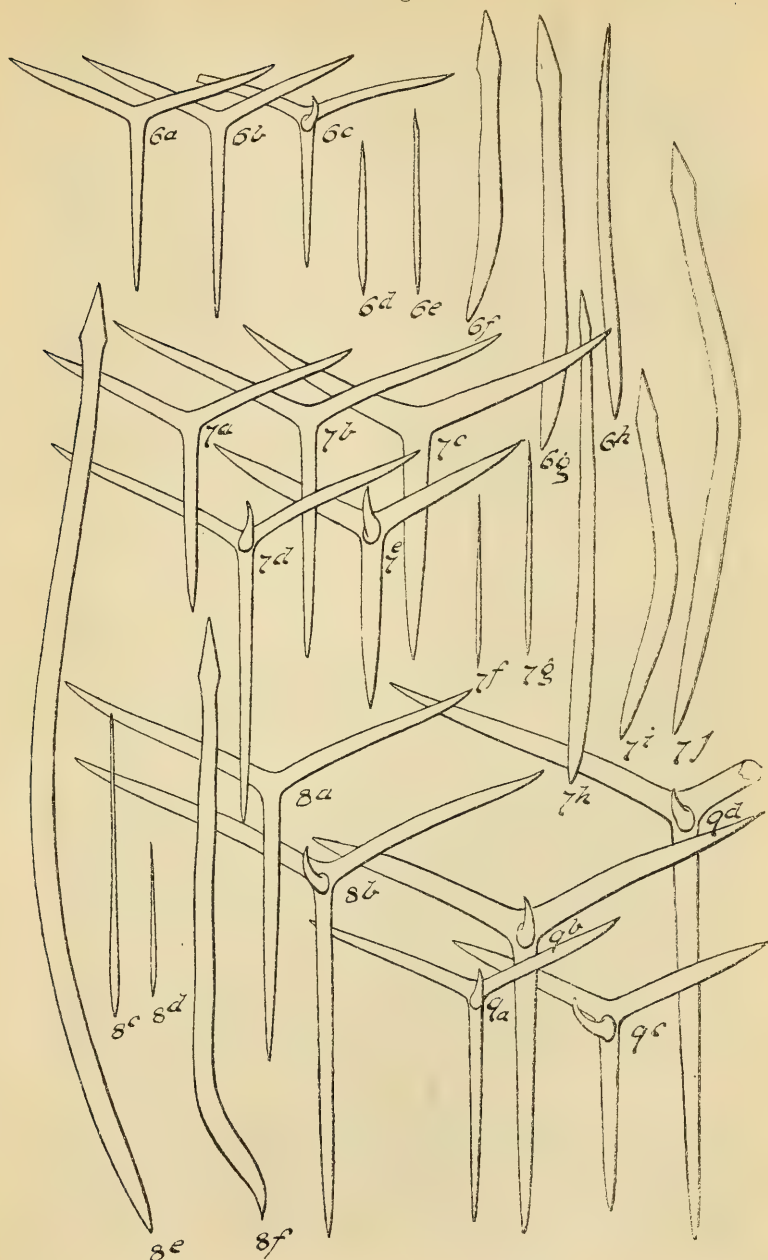
The large barbed monaxons (*b*, 1) show great variations as regards curvature and length, but remain remarkably constant in their general appearance, as well as in thickness. Only in one specimen, No. 4 of my list, have I remarked a tendency to be below the normal in this respect (text-fig. 92, figg. 4 *a*–4 *c*, p. 367). In length they may vary from 80 μ to nearly half a millimetre, perhaps even more in some cases. The unbarbed large monaxons vary from straight to slightly curved, and may also vary in dimensions. But the greatest variations are shown by the slender monaxons (*b*, 3). In the first place, while, as a rule, they show no trace of a lance-head, in some cases they exhibit very distinctly a rudimentary barb at the distal end. This is the case in the specimen in Canon Norman's collection identified by Haeckel as *complicata*, No. 1 of my list (text-fig. 92, figg. 3 *f*–3 *i*, p. 367). But the greatest variation is seen in length. In almost every specimen they vary greatly in

Explanation of Text-fig. 93 (opposite).

Spicules of *Leucosolenia complicata*.

Figg. 6 *a*–6 *h*. Spicules of one of the type specimens of Bowerbank's *Leucosolenia contorta* (British Museum, Bowerbank's Collection, No. 988, left-hand middle specimen), showing triradiate systems of unusually small size. *a* & *b*, triradiates; *c*, a quadri-radiate; *d* & *e*, slender monaxons showing distinct barbs; *f* & *g*, large barbed monaxons; *h*, a large monaxon without barb.—Figg. 7 *a*–7 *j*. Spicules of a specimen in the British Museum (Reg. No. 95.4.6.1) labelled "*Leucosolenia botryoides*" in Bowerbank's handwriting and "type sp." in Carter's handwriting. *a* & *b*, ordinary triradiates; *c*, a thickened triradiate; *d*, an ordinary quadri-radiate; *e*, a thickened quadri-radiate; *f* & *g*, slender monaxons; *h*, a large monaxon without barb; *i* & *j*, large barbed monaxons.—Figg. 8 *a*–8 *f*. Spicules of a specimen in the British Museum (Reg. No. 95.4.6.2) labelled "*Leucosolenia botryoides*" in Bowerbank's handwriting and "type sp." in Carter's handwriting, showing all the spicules above the average in size. *a*, a triradiate; *b*, a quadri-radiate; *c* & *d*, slender monaxons; *e* & *f*, large barbed monaxons.—Figg. 9 *a*–9 *d*. Quadri-radiate spicules of a specimen from Banyuls-sur-Mer, sent to me by Topsent, showing the unusually large size and thickness reached by some of the spicules (*b* and *d*).

Text-fig. 93.



this respect; but in the specimen (No. 4) already referred to as having a tendency to diminution in the thickness of the large monaxons, the slender forms are found varying from short ones of 50μ in length to long hair-like forms exceeding half a millimetre in length (text-fig. 92, figg. 4 *d*-4 *j*, p. 367). The monaxons showing this extraordinary development also tend to become abnormal in form; for whereas the ordinary examples of this type of spicule are characterised by their perfect straightness and absence of any curvature, the elongated forms become irregularly curved and wavy. I consider the special development of these spicules in this specimen as an abnormality, due perhaps to some special conditions of its habitat, of which unfortunately no record is preserved. Another specimen in which the slender monaxons are greatly elongated, but to nothing like the same extent, is seen in No. 10 (text-fig. 92, figg. 5 *a*-5 *g*, p. 367). This specimen is unique, in my experience, in another respect. While in all other specimens I have seen the monaxons are distinguished by their slenderness, whatever their length, from the other classes of monaxons present, in this specimen these slender forms show a tendency to become thickened and at the same time evenly curved, thus indicating a transition to the thicker types.

(c) *General Remarks on the Species.*

This sponge, as has been said, was first described by Montagu in 1812 under the name *Spongia complicata*; but its distinctness was not generally recognised until Haeckel in 1872 gave it precise characters, thus determining definitely the species which must henceforth bear the name *complicata*, whatever Montagu's specimen may have been.

Unfortunately, Haeckel overlooked the small monaxons in some of his specimens, for which he retained the name *complicata*, but saw them in a specimen for which he founded a new species, *pinus*, which must therefore rank as a synonym. There are, moreover, other species in his monograph which must be put as synonyms of *complicata* until further evidence be forthcoming as to their distinctness.

First and foremost among these is *Ascartis fabricii*, the *Leucosolenia fabricii* of Oscar Schmidt. There is nothing whatever in Schmidt's or in Haeckel's descriptions to differentiate this species from *complicata*. The diagnostic feature, absence of quadri-radiates, is insufficient, since Haeckel records the frequent presence of this type of spicule, and founds on it a "connexive Varietät" which he names *Ascandra fabricii*. This proves that the diagnostic *absence* of quadri-radiates was in reality merely *scarcity*, a common variation of this sponge. The small monaxons are not mentioned by either writer, but Schmidt's brief description testifies to his having made a most cursory examination of the sponge, and Haeckel overlooked them also in his *complicata*, so that this point

counts for nothing. Haeckel's figure of *fabricii*, evidently much reconstructed and embellished, may be taken to represent an arborescent specimen of *complicata*.

Secondly, Haeckel's species *Asculmis armata* appears to me to be founded simply on the converse variation of *complicata*—that is to say, on specimens (*Olynthus*-forms) in which triradiates were scarce. Here also we have a "connexive Varietät," *Ascandra armata*. There is nothing in Haeckel's description to separate this species from *complicata*. Haeckel's two varieties of *Asculmis armata*, named by him var. *norvegica* and var. *pocillum*, are formed on variations in the length of the gastral rays, which can be found in any specimen of the sponge*.

I consider it also highly probable that Haeckel's *Ascyssa acufera* will prove, when re-examined, to be a specimen of this species. Since in *Leucosolenia* the monaxons are always the first spicules to appear at the metamorphosis, every species of *Leucosolenia* is at first an "*Ascyssa*."

Haeckel further made two varieties of *complicata*. The first he named *hispida*, which was characterised by having the "lateral rays straight or only slightly curved; monaxons also slightly curved, with lance-head scarcely distinct." The second, named *amæboides*, has "lateral rays strongly curved in the form of an S; monaxons also slightly curved, with lance-head sharply distinct." Since all the variations of the spicules mentioned can be found in any specimen, it is not necessary to cumber taxonomy with these names.

Breitfuss, in his memoirs on calcareous sponges [2-5], seems to have consistently confused this species with *Clathrina contorta*; he has certainly done so, as pointed out below, in his 'Catalogue of the Calcareous in the Berlin Museum' [3]. In his work upon the calcareous sponge-fauna of the White Sea [2] he figures (pl. i. fig. 1), under the name *Ascandra contorta*, a sponge which is certainly not the species with which it is identified, but is clearly a *Leucosolenia*, and resembles the ordinary arborescent form of *complicata*. The description of the spiculation is inadequate even for determining the genus, but, so far as it goes, agrees with *L. complicata*.

The diagnostic features of this species are:—(1) the elongation of the unpaired ray of the triradiate systems relatively to the lateral rays; (2) the presence of two distinct forms of monaxons—the first small, straight, slender, usually without a barb at the distal extremity; the second large, curved, thick, usually with a distinct barb: the former are often scarce, but never apparently entirely lacking, *pæce* Haeckel.

* Haeckel at first considered the *Spongia pocillum* of O. F. Müller (1776, Zool. Dan. Prodr. p. 256) and Fabricius (1780, Faun. Grœnland, p. 449) to be identical with *Asculmis armata*; but as it is quite impossible to identify *Spongia pocillum* from their descriptions, it must be considered a *nomen nudum*, of no systematic importance.

(d) *List of Specimens examined*.*

(a) From Canon Norman's Collection.

1. Dried specimens collected at Scarborough by Bean, sent to Haeckel for examination, and returned by him with the following label in his handwriting:—

"*Ascandra complicata* H.

"(*Spongia complicata* Montagu).

"Scarborough (Bean)."

These specimens were of the utmost importance, as they showed that the small monaxons supposed to be absent in *Ascandra complicata* H. and present in *A. pinus* H. were simply overlooked by Haeckel in the specimens referred by him to the former species (see text-fig. 92, figg. 3*f-i*, p. 367).

2. Dried specimens labelled "*Leucosolenia contorta*, Guernsey," in Bowerbank's handwriting. According to information given me by Canon Norman, the specimens seen by me were not sent to Haeckel, but are of the same lot as the type sent to him, and are equally types of *Ascandra contorta* H. My preparation shows typical spicules of *Leucosolenia complicata* mingled with spicules of *Clathrina coriacea*. These two species often grow in the closest proximity; and I have a series of sections of *Clathrina coriacea* showing tubes of *Leucosolenia complicata* growing side by side with those of the *Clathrina*.

(b) From the British Museum.

3. Bowerbank Coll., No. 988. Seven dried specimens stuck on a card, and labelled in Bowerbank's handwriting "*Leucosolenia contorta*, Guernsey." These specimens are the types of Bowerbank's species *L. contorta*, figured by him in Mon. Brit. Spong. pl. iii. figg. 5–10. One specimen is much larger than the others; it is stuck at the top of the card, over the middle. The other six specimens are arranged in two vertical rows, three in each row, along the two sides of the card. Of the seven specimens I have examined six, that is to say, all except the right lower specimen, which is very small. The large specimen (Bowerbank's fig. 7) is a *Clathrina* sp. which agrees with Haeckel's *Ascandra contorta* in spiculation, except for the absence of monaxons, which I have not been able to find. The five smaller specimens examined by me are one and all of them unmistakable specimens of *Leucosolenia complicata*, but being very young colonies the spiculation is sometimes rather aberrant; especially in the triradiates; the three types of monaxons, however, show the specific characters quite invariably. The spicules are generally

* In the lists of specimens enumerated by me, I count only public specimens, so to speak, without mentioning the many examples I have studied in my own or other private collections.

small, as shown in text-fig. 93, fig. 6, p. 369, which is drawn from the left-hand middle specimen. The large monaxons are often short and stumpy, especially in the right-hand middle specimen, which is further unique, in my experience, in that the unpaired rays of some of the triradiates are shorter than the paired rays. In general, these young specimens do not show the characteristic elongation of the unpaired ray so markedly as the larger specimens examined by me.

4. Bowerbank Coll., No. 987. Labelled, in Ridley's handwriting, "*Grantia botryoides*. North Harbour, Peterhead Beach. No. 4, 1851. J. S. Bowerbank." A somewhat abnormal specimen of *L. complicata* (see text-fig. 92, figg. 4 a-4 j, p. 367).
5. Bowerbank Coll., No. 986. Bowerbank's label, copied by Ridley, is as follows—" *Grantia botryoides* John. Guernsey. Mr. Buckland."
6. Register No. 72.5.4.1 a. "*Leucosolenia botryoides*," Vigo Bay, Saville Kent.
7. Bowerbank Coll., No. 992 a. Dried specimens stuck on a card, labelled "*Grantia botryoides*," locality Orwell River.
8. Register No. 95.4.6.1. Labelled "*Leucosolenia botryoides*" in Bowerbank's handwriting and "type sp." in Carter's handwriting, meaning apparently Bowerbank's type (see text-fig. 93, figg. 7 a-7 j, p. 369).
9. Register No. 95.4.6.2. Labelled exactly as the last (see text-fig. 93, figg. 8 a-8 f, p. 369).
10. Register No. 85.1.9.32-34. Labelled "Calcarea, about 15 fathoms off Port St. Mary, I. of Man. J. Lomas, Esq." Rather an abnormal specimen of *complicata* (see text-fig. 92, figg. 5 a-5 h, p. 367).
11. Register No. 85.3.6.6. A beautiful specimen labelled "*? Leucosolenia botryoides*. Jersey, Saville Kent," in Carter's handwriting.

(c) From the Berlin Museum.

12. No. 1780. Labelled "*Ascandra contorta* H. Jersey" *.

2. LEUCOSOLENIA VARIABILIS.

? *Spongia confervicola* Templeton, 1836, Magazine of Nat. Hist. ix. p. 470, fig. 67.

Grantia botryoides var. *himantia* Johnston, 1842, Brit. Spong. and Lith. p. 179, pl. xxi. fig. 3.

Leucosolenia (*Leuciria*) *variabilis* Haeckel, 1870, Jena. Zeitschr. v. p. 243.

* In the Catalogue of the Calcarea of the Berlin Museum, published by Breitung [3], this specimen, No 1780, and others are put down with the labels copied from the bottles, without, apparently, any attempt at verification. The author is evidently unacquainted with *Ascandra* (*Clathrina*) *contorta*; otherwise a glance at the specimen would have prevented his making this error: but it is surprising that he did not examine the spiculation.

- Sycorrhiza corallorrhiza* Haeckel, 1870, l. c. p. 249.
- Ascandra variabilis* Haeckel, 1872, Kalkschwämme, ii. p. 106. iii. pl. 16. figg. 4 a-4 l and pl. 18.
- Ascortis corallorrhiza* Haeckel, 1872, l. c. p. 73, pl. 11. fig. 4, pl. 12. figg. 4 a-4 i.
- Leucosolenia botryoides* Bowerbank, 1874, Mon. Brit. Spong. iii. pl. iii. figg. 1-4.
- Leuconia somesii* Bowerbank, 1874, l. c. p. 334, pl. xci. figg. 6-17.
- Ascandra tenuis* Schuffner 1877, Jena. Zeitschr. xi. (n. F. iv.), p. 406, pl. xxv. fig. 8.
- Ascandra variabilis* Bowerbank and Norman, 1882, Mon. Brit. Spong. iv. p. 227.
- Ascandra botryoides* Fristedt, 1885, K. Vetensk.-Akad. Handlingar, xxi. no. 6, p. 9.
- Leucosolenia variabilis* Topsent, 1891, Arch. Zool. Exp. (2) ix. p. 525.
- Leucosolenia variabilis* Topsent, 1894, Rev. Biol. Nord France, vii. p. 2.
- Leucosolenia variabilis* Minchin, 1896, Ann. Mag. Nat. Hist. (6) xviii. p. 359.
- Ascandra variabilis* Breitfuss, 1898, Arch. f. Naturges. lxiii. i. p. 215.
- Ascandra variabilis* Breitfuss, 1898, Arch. f. Naturges. lxiv. i. p. 286.
- Ascandra corallorrhiza* Breitfuss, 1898, l. c. p. 285.
- Ascandra variabilis* Breitfuss, 1898, Mém. Acad. St. Pétersbourg, (8) vi. p. 16.
- Ascandra corallorrhiza* Breitfuss, 1898, l. c. p. 9.
- Ascandra variabilis* Breitfuss, 1898, Ann. Mus. Zool. St. Pétersbourg, 1898, p. 28.
- Ascandra corallorrhiza* Breitfuss, 1898, l. c. p. 17.
- Leucosolenia variabilis* Minchin, 1900, in Lankester's Treatise on Zoology, ii. Sponges, p. 5, fig. 5.
- Ascandra variabilis* Arnesen, 1901, Bergens Mus. Aarbog, 1900, No. 5, p. 15.
- Ascandra corallorrhiza* Arnesen, 1901, l. c. p. 14.
- Leucosolenia variabilis* Rousseau, 1903, Mém. Soc. Malac. Belgique, xxxvii. p. 8, fig. 4.
- Leucosolenia variabilis* Allen, 1904, J. Mar. Biol. Assoc. n. s. vii. p. 185.

(a) *External Characters.*

L. variabilis is known to me both in the spreading and the bushy form. Of the former type I have two typical specimens, both from Roscoff. A portion of one of them has been figured by me elsewhere [16, p. 5, fig. 5]. It was growing on a granite rock, and an attempt was made to detach the piece of stone to which the sponge was attached by means of hammer and chisel; as a result of this somewhat violent treatment, the slab broke

across under the middle of the sponge-colony, which was thus detached in two halves and somewhat damaged, but still showing well the peculiarities of this mode of growth. The spiculation of this specimen was found to be normal in all respects. My second specimen of the spreading form was removed entire from the rock on which it grew; it is a small colony remarkable for the close network of basal tubes, giving the sponge almost the appearance of a *Clathrina*, were it not for the characteristically large oscular tubes. The spiculation of this specimen shows a comparative scarcity of monaxons and unusually small triradiate systems; in other respects, however, the characters are typical (text-fig. 95, figg. 14 a-14 f, p. 379). Johnston [14, pl. xxi. fig. 3] has figured a typical spreading specimen of *variabilis* under the name of *Grantia botryoides* var. *himantia*, which Haeckel has wrongly placed as a synonym of *Clathrina coriacea*.

L. variabilis occurs most commonly in the bushy form as a compact reticulum of fine anastomosing basal tubes from which arise the stouter oscular tubes, often closely packed and of considerable length. In this form it may be found in rock-pools attached between the stems of algæ, or creeping over the algæ themselves. In the former situation the basal portion of the sponge is often half buried in mud and sediment, and, doubtless in consequence of this, the oscular tubes grow to a great size and length. I have such a specimen from Plymouth, in which the oscular tubes average 1.5 cm. in length, reaching in some cases 2 cm.; the spiculation of this specimen (text-fig. 95, figg. 15 a-15 f; p. 379) is remarkable for the large size of the triradiate systems. It is more usual, however, for the sponge to form a creeping growth over the algæ themselves—either twining amongst the filaments of confervæ, as Haeckel's fig. 6 on pl. 18 of the 'Monographie' [13] shows fairly correctly, or spreading over the stems of stouter seaweeds. These creeping forms are commonly found at Roscoff in situations where they are left dry at all tides, growing amongst the stems of the dense growth of algæ covering isolated boulders on the seashore. The youngest colonies form a delicate network spreading over the seaweed stems and sending up oscular tubes at intervals, thus having a form similar to the spreading colonies already described; but with further growth the basal tubes form a compact tangled mass from which long oscular tubes arise or hang down as the case may be.

In all the modifications of form exhibited by this sponge the most constant feature is to be found in the oscular tubes, which show little or no tendency to throw out diverticula except near their base. Hence the sponge shows numerous oscular tubes arising from the basal reticulum, each long, slender, generally slightly curved and smooth, *i. e.* free from diverticula from near their base up to the oscular opening. We find the sharpest contrast, as has already been stated above, with *L. complicata* in this respect, and the typical arborescent form of the latter is never found in *L. variabilis*.

Haeckel has given a plate (Monographie, pl. 18) intended to represent the form-variations of *L. variabilis*, but, in my opinion, the greater number of his figures are untrue to nature. The most charitable interpretation that can be put upon this plate is to suppose that many of the specimens figured are incorrectly determined and are not *L. variabilis* at all. Thus fig. 12 is evidently a *Clathrina*, and fig. 15 is either a contracted *Clathrina*, probably *coriacea*, or possibly a specimen of *variabilis* in which, owing to rough usage, all the oscular tubes have been knocked off. Fig. 2 probably represents some of the Sycons which, as I have stated below, are commonly found growing in company with *L. variabilis*, and the same interpretation possibly applies to figg. 1 and 3, the latter being contracted; what figg. 10 and 13 may be I should not like to assert, but they are certainly not specimens of *variabilis*. On the other hand, figg. 8 and 14 are probably specimens of *variabilis*, which owe the extraordinary curves exhibited by their oscular tubes to shrinkage as the result of desiccation. The imaginative figures given by Haeckel on this and other plates are responsible for the general opinion, far from being true, that any Ascon may assume any form in which any other species of Ascon occurs.

As compared with other species, I find a tendency in *variabilis* for the oscular rim to be of greater length. In young specimens this is sometimes very marked indeed. The body-wall of *variabilis* is generally thicker and stronger than in *L. complicata*, and the sponge is evidently harder, as seen from the more exposed situations in which it grows.

(b) Characters of the Spiculation.

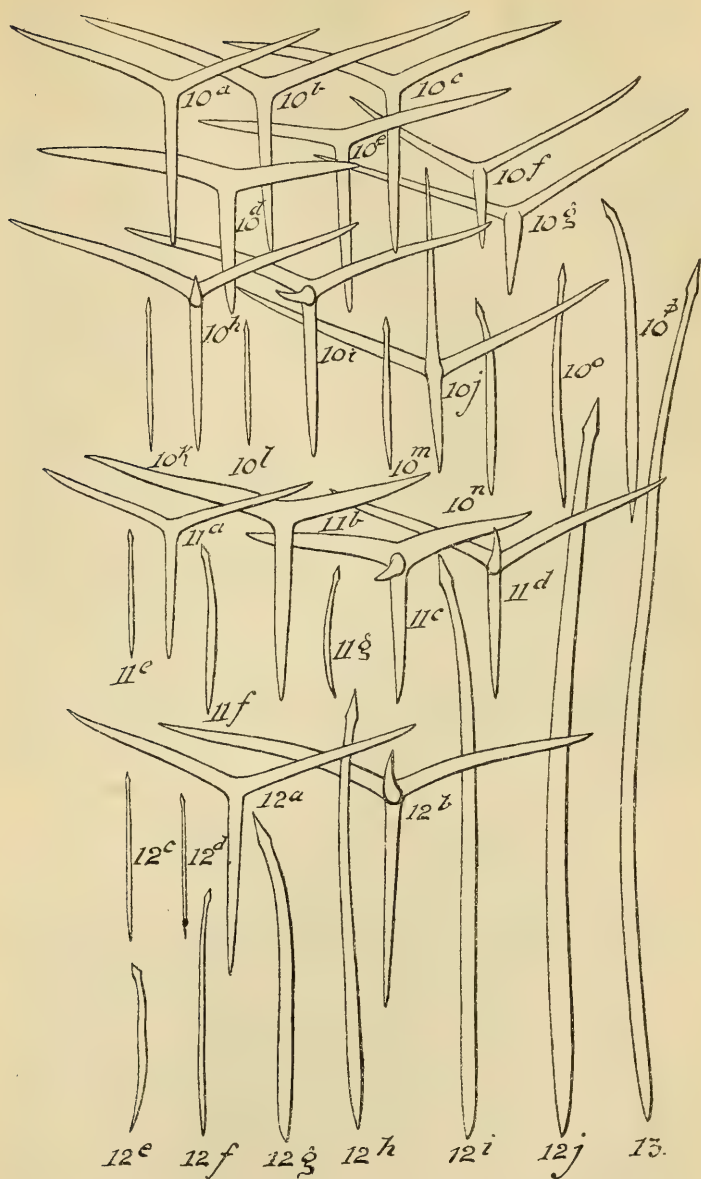
(a) *Triradiate and Quadriradiate Systems*.—(1) The ordinary triradiates (text-fig. 94, figg. 10 a–10 c, &c., p. 377) have the rays slender or of moderate thickness and tapering gradually to sharp points. The unpaired ray is straight, and distinctly shorter than, very rarely as long as, the paired rays. The unpaired angle is always much greater than 120°. The paired rays usually show a distinct double curvature, each ray curving first backwards, then forwards

Explanation of Text-fig. 94 (opposite).

Spicules of *Leucosolenia variabilis*.

Figg. 10 a–10 p. Spicules of a specimen with monaxons not reaching a large size, from Roscoff. a–c, ordinary triradiates; d, e, T-shaped triradiates (in this specimen not greatly thickened); f, g, brackets; h, i, ordinary quadriradiates; j, bracket with long gastral ray; k, l, straight slender monaxons; m–p, ordinary curved monaxons.—Figg. 11 a–11 g. Spicules of another specimen from Roscoff, in which all the monaxons are small. a, b, triradiates; c, T-shaped quadriradiate; d, ordinary quadriradiate; e, straight slender monaxon; f, g, curved monaxons.—Figg. 12 a–12 j. Spicules of a specimen from Roscoff in which the monaxons vary up to a large size. a, triradiate; b, quadriradiate; c, d, straight slender monaxons; e–j, curved monaxons.—Fig. 13. Monaxon of large size from a Roscoff specimen.

Text-fig. 94.



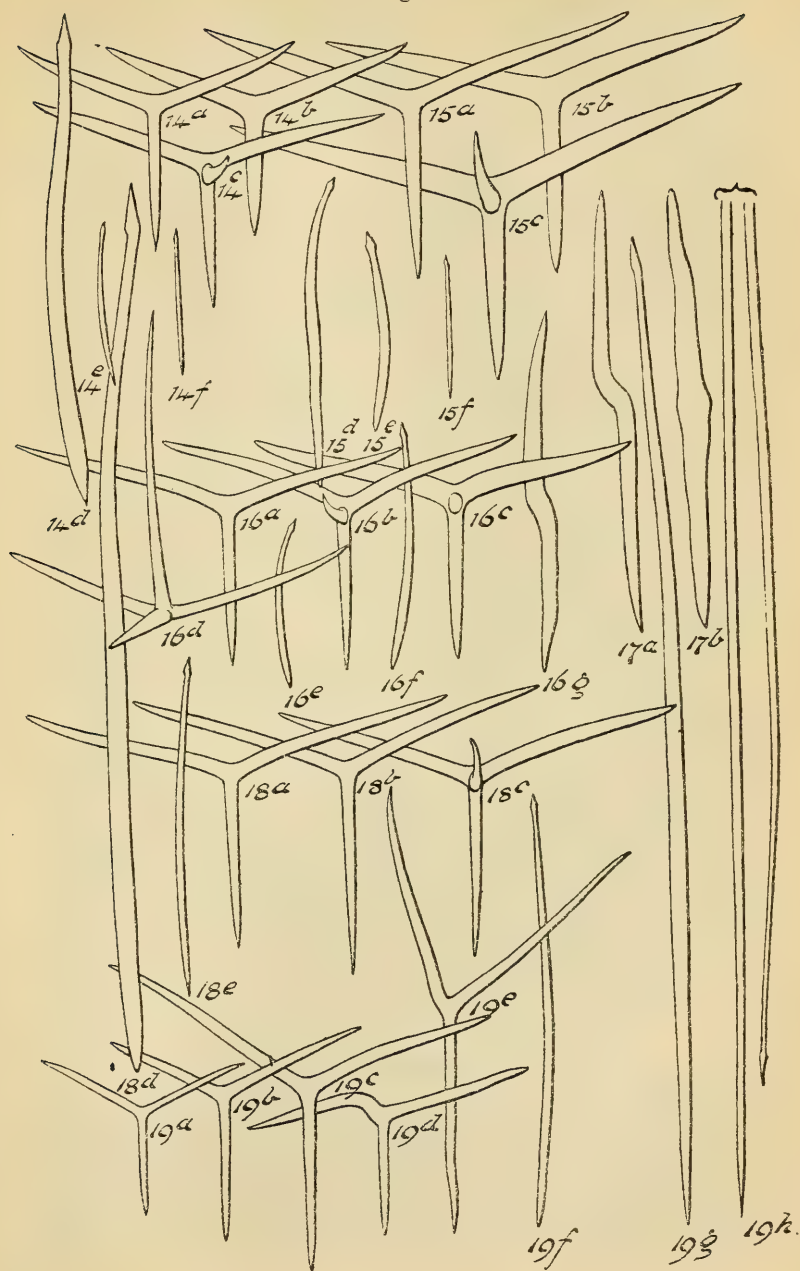
at the distal extremity, but the curvature may be very slight, all three rays then being practically straight. The unpaired rays vary from $65-83\ \mu$ in length and are about 6 or $7\ \mu$ in thickness; the paired rays range from $80-100\ \mu$ in length, with a breadth of 7 or $8\ \mu$. (2) In most specimens thicker triradiates occur (text-fig. 96, fig. 21 *c*, p. 381) with the anterior angle approaching 180° , so that the spicule appears nearly T-shaped. The paired rays, seen in facial aspect, may appear nearly straight, but more usually the proximal backward curve of the ray is short, while the distal forward curvature extends over more than half the length of the ray. The system as a whole is strongly concave on the gastral face, so that when seen in facial aspect from the gastral side one of the two paired rays is usually very much foreshortened, and therefore appears different in length and curvature from the other. The rays reach $10\ \mu$ in thickness. (3) In all specimens peculiarly modified triradiates occur which may be termed *brackets* (text-fig. 94, figg. 10 *f*, 10 *g*, p. 377). The two paired rays are straight or curved, and more or less normal as regards length and proportions, though in some cases rather slender; the unpaired ray, on the other hand, is short and strongly curved out of the plane in which the paired rays lie, so that in a facial view of the spicule it is not in focus at the same time as the paired rays. The unpaired ray is often irregularly curved, and may be reduced to a mere knob or even to the vanishing point. (4) The ordinary quadriradiates (text-fig. 94, figg. 10 *h*, 10 *i*, &c., p. 377) have the basal rays similar to (1); the gastral ray is of moderate length, smooth, and evenly curved at the tip. (5) The thickened T-shaped triradiates, as in (2), may develop a gastral ray, which is then rather thick and set very upright on the basal system (text-fig. 94, fig. 11 *c*, p. 377; text-fig. 96, fig. 21 *g*, p. 381). (6) The brackets may also bear a gastral ray, which is then usually of very great

Explanation of Text-fig. 95 (opposite).

Spicules of *Leucosolenia variabilis*.

Figgs. 14 *a-14 f*. Spicules of a specimen from Roscoff showing triradiates of unusually small size. *a, b*, triradiates; *c*, quadriradiate; *d, e*, curved monaxons; *f*, straight monaxon.—Figgs. 15 *a-15 f*. Spicules of a specimen from Plymouth showing triradiate systems unusually large. *a, b*, triradiates; *c*, quadriradiate; *d, e*, curved monaxons; *f*, straight monaxon.—Figgs. 16 *a-16 g*. Spicules of a specimen from Bantry Bay, Ireland, in Norman's collection, identified by Haeckel as *Ascandra variabilis*. *a*, triradiate; *b, c*, quadriradiates; *d*, bracket with greatly elongated gastral ray; *e, f*, curved monaxons; *g*, bayonet-like monaxon.—Figgs. 17 *a, 17 b*. Bayonet-like monaxons of a specimen from a tide-pool below the Hoe, Plymouth.—Figgs. 18 *a-18 e*. Spicules of the specimen from Brighton Aquarium figured by Bowerbank ('British Spongiadæ', iii. pl. xci. fig. 7) under the name *Leuconia somesii* (Brit. Mus. Bowerbank Coll. 1019). *a, b*, triradiates; *c*, quadriradiate; *d, e*, curved monaxons showing their great variation in size.—Figgs. 19 *a-19 h*. Spicules of another of Bowerbank's specimens of *Leuconia somesii* (l. c. pl. xci. fig. 6) (Brit. Mus. Bowerbank Coll. 1017) showing a tendency to develop abnormal forms of the triradiates and monaxons of great length, irrespective of thickness. *a-e*, triradiates; *f-h*, monaxons; *h*, on account of its great length, has been drawn in two pieces.

Text-fig. 95.



length, reaching $120\ \mu$ or more, and tapering gradually to a sharp point (text-fig. 94, fig. 10 *j*, p. 377; text-fig. 95, fig. 16 *d*, p. 379).

(b) *Monaxon Spicules*.—Three kinds occur, two invariably, the third only to be found in certain specimens. (1) The ordinary monaxons (text-fig. 94, figg. 12 *e*–12 *j*, &c., p. 377) are curved and have distinct lance-heads, and vary greatly in size, in the same or in different specimens, ranging from 80 to $320\ \mu$ in length and 2 to $9\ \mu$ in thickness; they cannot, however, be divided into two distinct classes as has been done by Haeckel, since every possible gradation is found from the smallest to the largest. The shaft is generally more or less straight for its proximal half or two-thirds and then has a slight bend, the distal fourth or sixth, however, with the lance-head, being nearly straight. The shaft is thickest in the region between a third and a half of its length from the proximal end. The proximal half or third is cylindrical and tapers abruptly to a point; the distal half or two-thirds tapers gradually and almost imperceptibly, dwindling to about half the greatest thickness when it reaches the small lance-head. (2) Very slender monaxons occur (text-fig. 94, figg. 10 *k*, 10 *l*, 12 *c*, 12 *d*, p. 377), easily found on account of their very refringent appearance and sharp outline, though they are much less abundant than (1). They have straight, very slender shafts and distinct lance-heads, and vary from 70 to $110\ \mu$ in length, never reaching a large size. (3) In some specimens fairly large bayonet-like spicules occur (text-fig. 95, figg. 16 *g*, 17 *a*, 17 *b*, p. 379) with a sharp bend in the middle, sometimes represented only by a swelling. They reach about $200\ \mu$ in length, varying in thickness from about 7– $10\ \mu$.

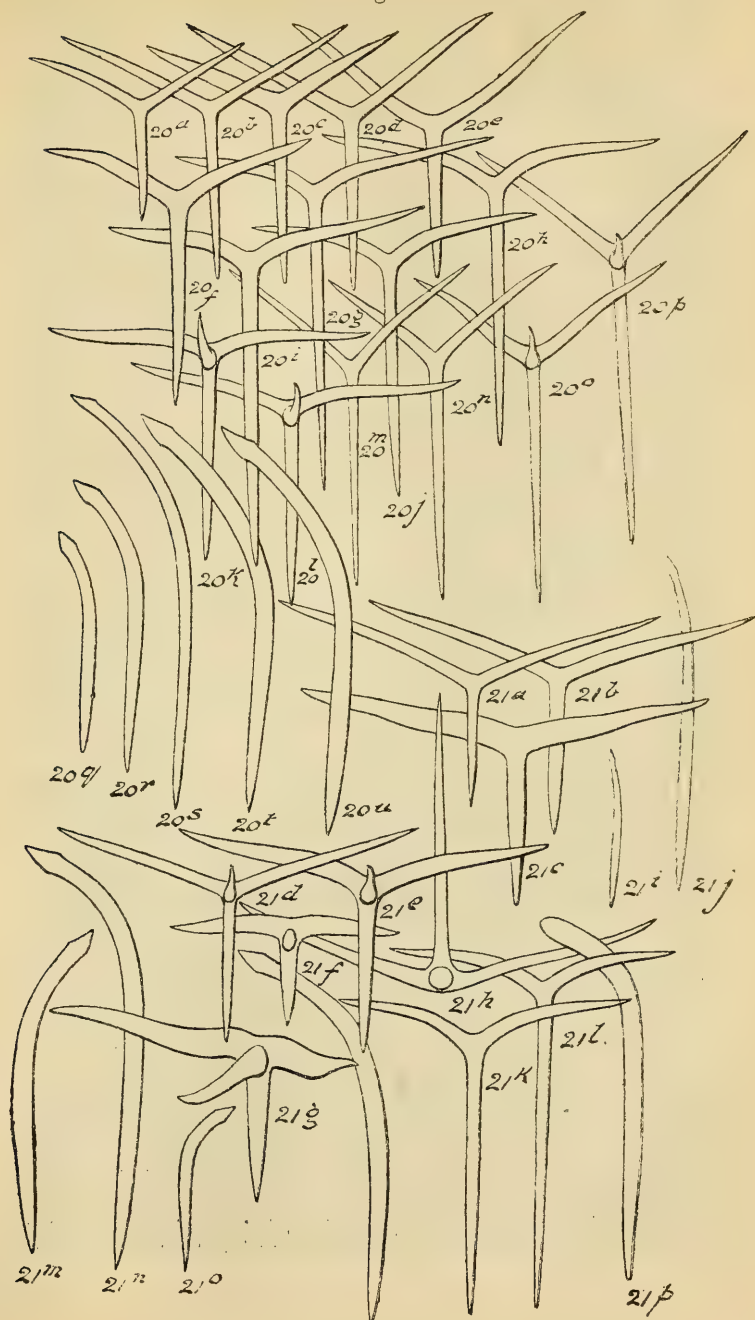
Variations of the Spiculation. (1) *As regards the relative numbers of the Spicules*.—In some specimens the triradiates and quadri-radiates are all of the ordinary slender type (*a*, 1 & 4) and none of the thickened T-shaped forms (as 2 & 5) are to be found, or only after much searching. In others they are more easily found. The brackets, with or without gastral rays (*a*, 3 & 6), are never very abundant and often scarce. Of monaxon spicules, the barbed forms (*b*, 1 & 2) are always present more or less abundantly, but in some specimens I have not succeeded in finding the large, bayonet-like forms (*b*, 3), in spite of much searching; in others they are easily found, and I have also come across one *in situ* in the body-wall of the sponge.

Explanation of Text-fig. 96 (opposite).

Spicules of *Sycon* sp. and *Leucosolenia variabilis*.

Fig. 20 *a*–20 *u*. Spicules of a *Sycon* found commonly occurring in company with *L. variabilis*, specimen from Roscoff. *a*–*e*, dermal triradiates; *f*–*j*, tubar triradiates; *k*, *l*, quadri-radiates from oscular rim; *m*–*p*, gastral triradiates and quadri-radiates; *q*–*u*, monaxons.—Fig. 21 *a*–*p*. Spicules of a specimen of *L. variabilis* from Bergen, Norway, identified by Haeckel as *Ascandra variabilis* (Berlin Mus. no. 417), showing admixture of *Sycon* spicules similar to those in the preceding figure. *a*–*c*, triradiates of *L. variabilis*; *d*–*h*, quadri-radiates of *L. variabilis*; *i*, *j*, monaxons of *L. variabilis*; *k*, *l*, tubar triradiates of the *Sycon*; *m*–*p*, monaxons of the *Sycon*.

Text-fig. 96.



(2) *As regards the form and size of the Spicules.*—The ordinary triradiates and quadriradiates vary considerably in size both in different and in the same specimens, though here, as in other species, one specimen may be found characterised by spicules generally above the average in size, another by spicules below the average. The smallest triradiates I have observed, occurring in a specimen from Roscoff, have the unpaired rays about 60μ , the paired rays about 70μ in length (text-fig. 95, fig. 14, p. 379). The largest I have seen have unpaired rays $95\text{--}100\mu$, paired rays $135\text{--}140\mu$, in length (text-fig. 95, fig. 15). In thickness also they vary considerably, ranging from $4\text{--}10\mu$ (text-fig. 96, fig. 21 a, p. 381, text-fig. 95, figg. 15 b, 15 c, p. 379), and, in the latter case, only differing from the T-shaped forms by the paired angles and the even curvature of the paired rays. On the other hand, as regards form and proportions, the triradiates are remarkably uniform, the unpaired ray being almost invariably shorter than the paired rays, usually very obviously so, and only very exceptionally equalling them in length.

The brackets are very variable both as regards the form and degree of development of the unpaired ray, and as regards the length of the gastral ray when developed; the latter always greatly exceeds in length, however, the gastral rays of the ordinary quadriradiates.

The curved monaxons (b, 1) are extremely variable in size. The normal condition is for every intermediate grade to occur between spicules of about 80μ in length and others three times as long. In some specimens, however, only small monaxons occur, in others the majority of them are large, reaching nearly 400μ in length and correspondingly thickened; but in the latter case small forms are always present in addition to the large, though they may be scarce by comparison.

The aberrant specimens of *L. variabilis* from Brighton Aquarium, which were described by Bowerbank under the name *Leuconia somesii* (text-fig. 95, figg. 18, 19, p. 379), are characterised by an extraordinary development of the monaxons, which, in addition to ordinary small and large forms, reach in other cases a great length (as much as 1000μ) combined with unusual slenderness for such a length ($2\text{--}5\mu$). The triradiates of these specimens are also characterised by great range of variation in size, and by the large number of abnormalities in this class of spicules.

In certain specimens of this sponge which I have been able to examine—specimens important for the reason that they had all been through Haeckel's hands—I was puzzled by finding certain types of spicules in my preparations in addition to those already described (text-fig. 96, figg. 21 k–21 p). The specimens in question were, first, four in Norman's collection (Nos. 1–4 of my list below); secondly, one in the Berlin Museum (No. 13 of my list) (text-fig. 96, fig. 21, p. 381). All these five specimens show the typical spiculation of *Leucosolenia variabilis*, the specimen from Polperro (No. 5) alone showing an admixture of

the spicules of *L. complicata*, so that the two species were evidently growing in close proximity, as so often occurs; but all of them show, as has been stated, additional spicules. Since *L. variabilis* forms a dense tangle amongst the seaweeds, hydroids, and other organisms, and might easily be involved in this way with quite distinct calcareous sponges, the idea occurred to me that the spicules in question might belong to another sponge; and on examining carefully my specimens of *L. variabilis* from Roscoff, and picking them over under a lens, I was able without difficulty to trace these spicules to their source. Growing on the seaweeds, in closest proximity, very often, to the tubes of the *Leucosolenia*, were numerous small Sycons, ranging in size from minute *Olynthi* to specimens a centimetre or more in height, but all alike showing a characteristic spiculation, which accounted at once for the intrusive spicules in my preparations. I have not been able to identify this sponge in Haeckel's monograph, neither among the Sycons nor the Leucons. I content myself, therefore, for the present, with describing the spiculation, and leave the identification of it to a future period, or to others. Five classes of spicules can be distinguished:—(1) Dermal triradiates (text-fig. 96, figg. 20 *a*–20 *e*, p. 381) tending to be irregular in form, often nearly equiangular; (2) tubar triradiates (*i. e.* from the walls of the flagellated chambers), with long straight unpaired ray, and shorter lateral rays characteristically curved, the unpaired angle very obtuse (text-fig. 96, figg. 20 *f*–20 *j*, p. 381); (3) gastral tri-radiates and quadriradiates, with long straight unpaired ray, shorter paired rays slightly curved, gastral ray present or absent, unpaired angle nearly a right angle or less, at any rate considerably less than 120° (text-fig. 96, figg. 20 *m*–20 *p*, p. 381); (4) quadriradiates from the oscular rim, the three basal rays nearly equal in length, the unpaired angle nearly 180°, so that the spicule is nearly T-shaped (text-fig. 96, figg. 20 *k*, 20 *l*, p. 381); and (5) monaxons of very characteristic form, the proximal half nearly straight, tapering to a point, the distal half curving evenly outwards, without any diminution in thickness, to the conspicuous, bluntly pointed lance-head. It is the presence of these monaxons that was so often noticed in my specimens of *Leucosolenia variabilis*; it is probable that such monaxons may often find their way even into pure cultures of the *Leucosolenia*, for if thrown off by the Sycons and washed about in the water they might easily come to stick to the *Leucosolenia* or to the seaweed on which it was growing.

(c) *General Remarks on the Species.*

Haeckel was the first to recognize the specific distinctions of this sponge and to describe accurately its distinctive characters, although it was common enough in collections long previous to Haeckel's monograph. Bowerbank, as has been already pointed out, figured this sponge and its spicules under the name *L. botryoides*, and again in another place as a new species under the name

Leuconia somesii; why he should have called these specimens *Leuconia* is a mystery to me.

Haeckel gave the species the name *variabilis* on account of "the unlimited changeableness of its form as a whole, as well as of its specific skeleton-structure." I have already expressed my opinion upon Haeckel's figures of the external form; as regards the spiculation, *L. variabilis* is variable certainly, but not more so than other Ascons. The frequent association, mentioned above, of this species with a heterocœle sponge, and the constant contamination, so to speak, of spicule-preparations of the Ascon by spicules not properly belonging to it, may account for Haeckel's noticing in this instance the variability of the spiculation.

Haeckel described *variabilis* as having two kinds of monaxons, small and large; but from his figure it is evident that the smaller kind seen by him were the small curved monaxons, and he did not notice that they are connected by every possible gradation of size with the large ones. He overlooked the small straight monaxons, as I must also confess to have done till quite recently. Haeckel made four specific varieties—*cervicornis*, *confervicola*, *arachnoides*, and *hispidissima*,—based on variations of the relative numbers of the different sorts of spicules, and leading up to his so-called "connexive varieties," distinguished, in his usual way, by ringing the changes on the generic name, such as *Ascaltis*, *Ascortis*, *Asculmis*, or *Ascyssa variabilis*. None of these varieties appears to me to have any taxonomic value except *hispidissima*, which might be retained for forms such as were named by Bowerbank *Leuconia somesii*: i. e. for those in which the monaxons are excessively developed in size and number to form a furry protective covering. In my specimens from Roscoff, even from the same rock, I find some which, viewed with a lens, appear smooth, others which appear hispid; the difference between them is merely one of the length attained by the monaxons (compare figg. 10-13, text-fig. 94, p. 377). The same is true of *L. complicata*, and there can be no doubt that these sponges respond readily in this manner to differences in their surroundings.

Of other species of Ascons in Haeckel's monograph, I feel no doubt whatever that his *Ascortis corallorrhiza* is founded on a specimen of this species with rather large and thick spicules (compare figg. 15 a-15 f, text-fig. 95, p. 379). Here also we have a connexive variety, *Ascandra corallorrhiza*, mentioned.

Systematists subsequent to Haeckel have for the most part recognized and identified this sponge correctly. A specimen, however, in the British Museum from Trieste, labelled *L. variabilis*, is certainly not this species. *L. variabilis* does not, to the best of my belief, occur in the Mediterranean; but it is impossible, I repeat, to make definite statements about the distribution of Ascons in the present confused state of their nomenclature*.

* Kirkpatrick, in 1901 (Brit. Mus. Rep. 'Southern Cross' Collections, p. 317), identified an Antarctic sponge as *L. variabilis*; but having been able, by the author's kindness, to examine the specimen I am in a position to state that it is not *L. variabilis* but a species, apparently new, allied to *L. complicata*.

The diagnostic features of this sponge are :—(1) The constant shortness of the unpaired ray of the triradiate systems relative to the lateral rays, and the wideness of the anterior angle, frequently nearly 180°; (2) the two kinds of monaxons, both barbed—straight refringent ones always slender and small, relatively scarce; and curved ones, varying from very small to very large, always abundant.

(d) *List of Specimens examined.*

(a) From Canon Norman's Collection.

1. Specimen from Bantry Bay, Ireland, with Norman's label "*Leucosolenia botryoides*," endorsed by Haeckel "*Ascandra variabilis*." (See text-fig. 95, figg. 16 a–16 g, p. 379.)
2. Specimens from Shetland, with label in Bowerbank's handwriting "*Grantia botryoides* Johnston, more largely developed than usual." Also a label by Norman "*Leucosolenia botryoides*, very large, Shetland," across which is written in Haeckel's handwriting "*Ascandra variabilis* H."
- * These specimens are of the same batch as No. 8 below.
3. Specimens received by Norman from Haeckel, collected at Bergen, Norway, with printed label "*Ascandra variabilis* H."
4. Specimen received by Bowerbank as a type of *Leucosolenia contorta*, from Guernsey; sent to Haeckel for examination, and returned with label in Haeckel's handwriting as follows :—

"*Ascandra contorta* H.

"(*Leucosolenia contorta* Bwbk.)

"Guernsey. Bowerbank."

The specimen is a quite typical *variabilis*, with a slight admixture of *Sycon* spicules.

5. Specimens growing on seaweed with *Grantia compressa*, from Polperro, Cornwall, and identified by Haeckel as *Ascandra variabilis*: my preparations show a mixture of spicules of *variabilis* and *complicata*.

(b) From the British Museum.

6. Bowerbank Coll., No. 1017. The type specimen of Bowerbank's "*Leuconia somesii*," figured in Brit. Spong. iii. pl. xci. fig. 6. With label in Bowerbank's handwriting—" *Leuconia somesii* Bwk., sent to me by Mr. H. Lee, 15.9.73, said to have been found alive in the aquarium " (*i. e.* at Brighton). (See text-fig. 95, figg. 19 a–19 h, p. 379.)
7. Bowerbank Coll., 1018. Another specimen with Bowerbank's label "*Leuconia somesii*, Brighton Aquarium, sent by Mr. Lee, 5.11.73." Figured in Brit. Spong. iii. pl. xci. fig. 8.
8. Bowerbank Coll., 1019. Another specimen with label similar to the last. Figured in Brit. Spong. iii. pl. xci. fig. 7. (See text-fig. 95, figg. 18 a–18 e, p. 379.)

9. Bowerbank Coll., 985. Specimen figured in Brit. Spong. iii. pl. iii. fig. 1, with label in Bowerbank's handwriting "*Leucosolenia botryoides*, Shetland." A quite normal specimen of *variabilis* with fairly large spicules.
 10. Bowerbank Coll., 979. Labelled in Bowerbank's handwriting "*Leucosolenia botryoides*, Shetland."
 11. Bowerbank Coll., 964. Label as in the foregoing.
 12. Register No. 47.9.7.112. Label "*Grantia botryoides* var." Holy Island, Johnston Collection.
[Register No. 83.12.4.17, labelled "*Ascandra variabilis* H. Adria, Triest," is a specimen of a species totally distinct from *variabilis*, which I have not yet been able to identify with certainty.]
- (c) From the Berlin Museum.
13. No. 417. Specimens received from Haeckel; locality Bergen. My preparation shows quite typical spicules of *variabilis* mixed with those of a Sycon. (See text-fig. 96, figg. 21 a-21 p, p. 381.)
- ### 3. LEUCOSOLENIA BOTRYOIDES.
- Spongia botryoides* Ellis & Solander, 1786, Nat. Hist. Zoophytes, p. 190, pl. lviii. figg. 1-4.
- Spongia botryoides* Montagu, 1812, Wernerian Mem. ii. p. 89.
- Spongia botryoides* pars Grant, 1826, Edinb. Phil. Journ. xiv. p. 339; Edinb. New Phil. Journ. i. p. 169.
- Spongia botryoides* pars Grant, 1827, Edinb. New Phil. Journ. ii. p. 135.
- Grantia botryoides* pars Fleming, 1828, Hist. Brit. Animals, p. 525.
- Calcispongia botryoides* de Blainville, 1836, Manuel d'Actinologie, p. 531.
- Grantia botryoides* pars Johnston, 1842, Brit. Spong. and Lithophytes, p. 178.
- Leucosolenia botryoides* Bowerbank 1864, Mon. Brit. Spong. i. p. 164, pl. xxvi. figg. 347, 348; (1866) ii. p. 28.
- Grantia lieberkühni* Schmidt, 1866, Spong. Adriat. Meer. Suppl. ii. pp. 8, 20.
- Leucosolenia botryoides* Gray, 1867, Proc. Zool. Soc. 1867, p. 555.
- Leucosolenia botryoides* Schmidt, 1868, Spong. Adriat. Meer. Suppl. iii. p. 31.
- Olynthium nitidum* Haeckel, 1870, Jena. Zeitschr. v. p. 237.
- Olynthium splendidum* Haeckel, l. c. p. 237.
- Leucosolenia (Leuceria) botryoides* Haeckel, 1870, l. c. p. 243.
- Leucosolenia granti* Haeckel, 1870, l. c. p. 243.
- Ascallis botryoides* Haeckel, 1872, Kalkschwämme, ii. p. 65, pl. 9. fig. 10, pl. 10. figg. 7 a-7 e.
- Ascandra botrys* Haeckel, 1872, l. c. p. 101, pl. 16. figg. 1 a-1 f.
- Ascandra nitida* Haeckel, 1872, l. c. p. 103, pl. 16. figg. 2 a-2 q, pl. 17. figs. 3, 7, 10, 13.

Ascandra botryoides Fristedt, 1885, K. Vetensk.-Akad. Handlingar, xxi. no. 6, p. 9.

Asclatis botryoides Hanitsch, 1890, Trans. Liverpool Biol. Soc. iv. p. 223.

Leucosolenia botryoides Minchin, 1896, Ann. Mag. Nat. Hist. (6) xviii. p. 359.

Leucosolenia botryoides Breitfuss, 1898, Arch. f. Naturges. lxiii. i. p. 210.

Ascandra botrys Breitfuss, 1898, l. c. p. 213.

Leucosolenia botryoides Rousseau, 1903, Mém. Soc. Malac. Belgique, xxxvii. p. 5, fig. 1.

Leucosolenia botryoides Allen, 1904, J. Mar. Biol. Assoc. n. s. vii. p. 185.

(a) *External Characters.*

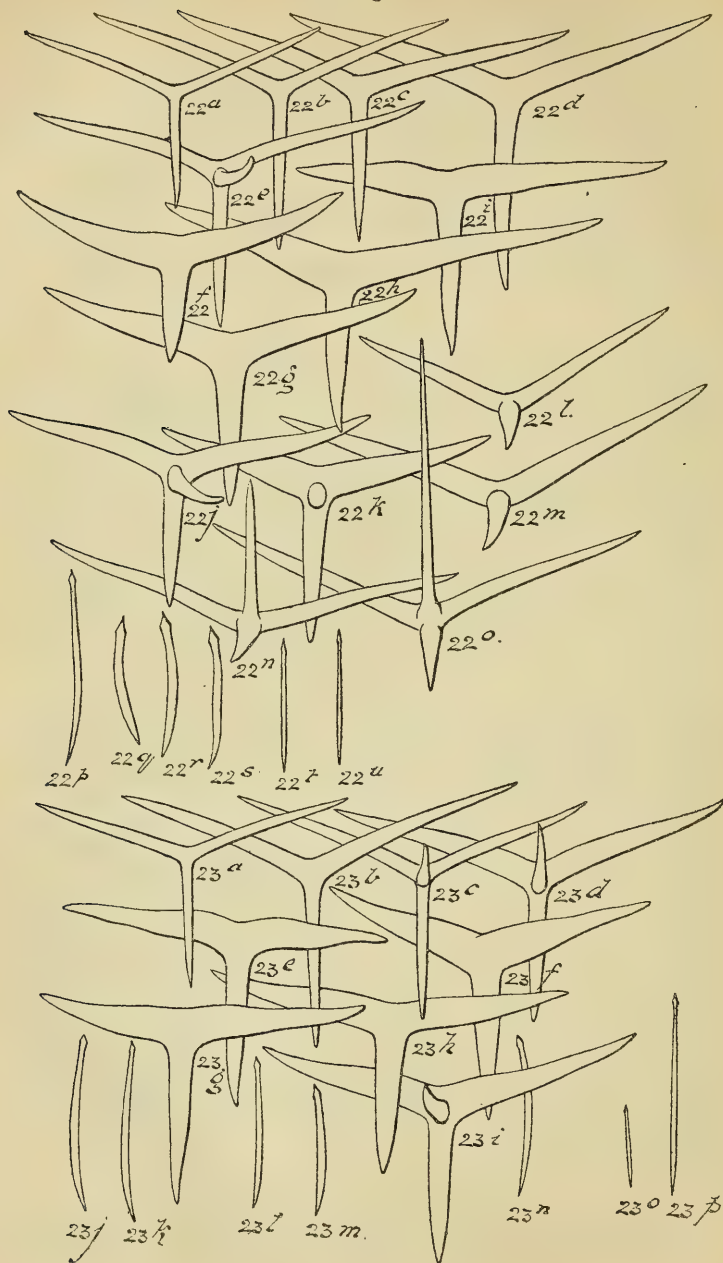
This sponge is only known to occur in one kind of situation and under one form. It is always found growing over algæ, forming a basal reticulum of finer tubes attaching it to its support, from which arises a dense cluster of short smooth oscular tubes. This extremely characteristic form is well seen in the figures of Ellis and Solander [7], Bowerbank [1, vol. i. fig. 348], and even Haeckel [3, pl. ix. fig. 10], and enables this species to be distinguished at once. The form of the sponge is usually compared to that of a bunch of grapes, hence the specific name *botryoides*; but since the oscular tubes are at least five or six times as long as they are broad, a bunch of bananas would be a better comparison as regards form.

I have not found *botryoides* at Roscoff, but at Plymouth it is not uncommon. In Wembury Bay I found it extremely abundant, competing with *Grantia compressa* for the occupation of the algæ on the overhanging sides of rocks, in situations where the sponges are left suspended high and dry at low tide. Its mode of growth may be compared with the bushy form of *variabilis* growing in similar situations. In fact, the only difference between the two sponges under these circumstances is that in *botryoides* the oscular tubes are shorter in proportion to their length and more thickly clustered together, so that the distinctiveness of the external form of *botryoides* is more apparent than real as regards mode of growth. The oscular rim in this species is short or of moderate length, and the oscular tube narrows more or less rapidly towards the opening, but in both these respects also the difference from *variabilis* is rather one of degree. The wall of the oscular tube is greatly thickened by quantities of stout spicules, and the sponge is much tougher and stronger than either of the preceding species.

(b) *Characters of the Spiculation.*

Since the spiculation of this species is modelled, so to speak,

Text-fig. 97.



almost exactly upon that of *L. variabilis*, and every class of spicule found in the one is found also in the other, it is only necessary to enumerate them in the same order as has been done for *L. variabilis*, and to give at the same time an account of their differences in the two species, and of their variations in the species under consideration.

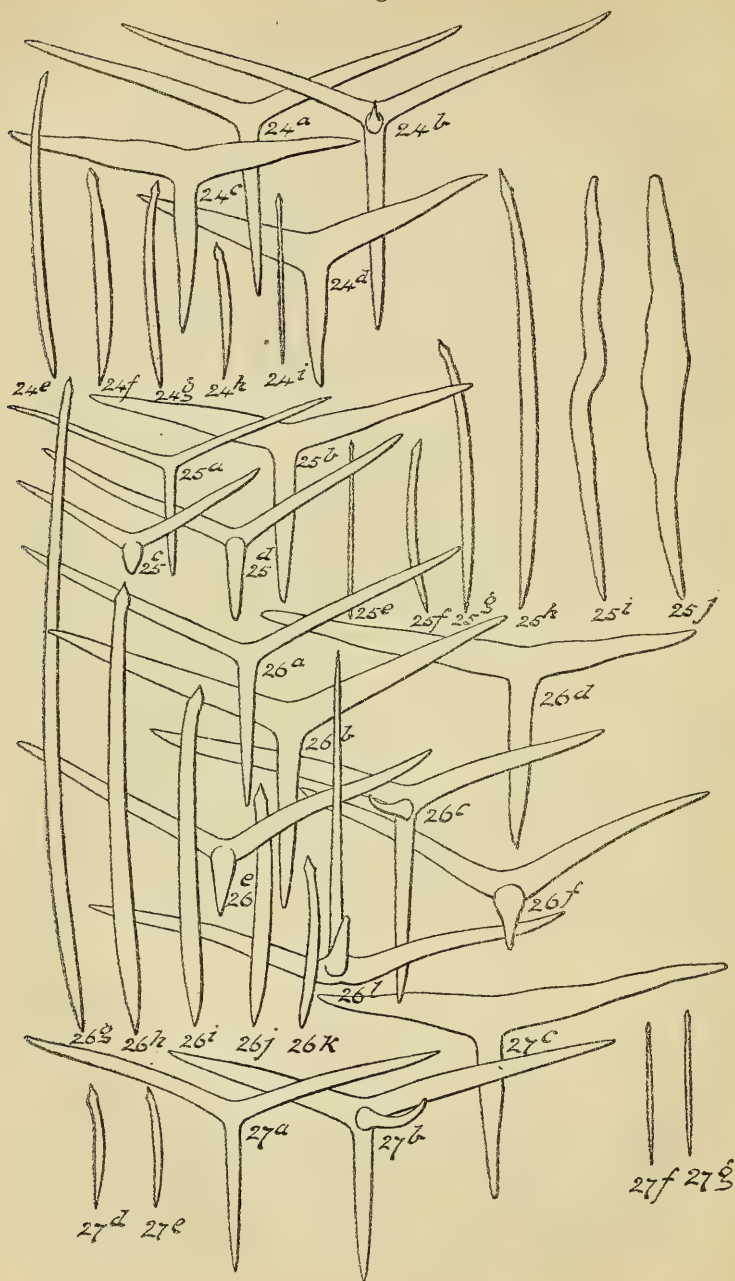
(a) *Triradiate and Quadriradiate Systems*.—(1) The ordinary triradiates (text-fig. 97, figg. 22 a–22 d, p. 388) have exactly the same characters as in *variabilis*, the unpaired ray short, the unpaired angle obtuse. They vary from slender spicules, the rays about $3\ \mu$ in thickness, to thick ones with the rays reaching about $10\ \mu$. There is often a tendency noticeable for the unpaired ray to be irregularly curved or bent. This is to be ascribed to the great number of spicules, closely packed in the body-wall of this sponge, in consequence of which the growing spicule-rays encounter obstacles to their growth which cause them to be deflected from their normal straightness. (2) The thickened T-shaped triradiates, comparatively few and far between in *variabilis*, are exceedingly abundant in *botryoides*, and constitute the most marked feature of the species (text-fig. 97, figg. 22 f–22 i, p. 388). They are thick, generally irregularly curved, with the paired rays usually much longer than the unpaired one, and when seen from the gastral aspect, if the spicule be lying so that one of the two paired rays and the unpaired ray are in focus at the same time, the other paired ray appears greatly foreshortened, giving the spicule an asymmetrical appearance (text-fig. 97, figg. 22 h, 22 i, p. 388). (3) The brackets are more abundant than in *variabilis* and show more tendency to modification and reduction of the unpaired ray (text-fig. 97, figg. 22 l, 22 m, p. 388), so that while in *variabilis* they might be overlooked, in *botryoides* they are easily found and recognised. (4) The ordinary quadriradiates are similar to those of *variabilis* (fig. 22 e). (5) The T-shaped quadriradiates are fairly abundant (figg. 22 j, 22 k) and, as in *variabilis*, the gastral ray is very upright or even inclined backwards in its basal two-thirds. (6) The brackets may develop a gastral ray, which, as described for *variabilis*, is usually straight and may reach a great length (figg. 22 n, 22 o). In some specimens this type of spicule is very abundant.

Explanation of Text-fig. 97 (opposite).

Spicules of *Leucosolenia botryoides*.

Figg. 22 a–22 o. Spicules of a specimen from Wembury Bay, Plymouth. a–d, ordinary triradiates; e, a quadriradiate; f–i, thickened T-shaped triradiates; j, k, T-shaped quadriradiates; l, m, brackets; n, o, brackets with gastral rays; p–s, ordinary curved monaxons; t, u, straight slender monaxons.—Figg. 23 a–23 p. Spicules of a specimen from Berwick Bay in Norman's Collection, identified by Haeckel as *Ascallis botryoides*. a, b, ordinary triradiates; c, d, ordinary quadriradiates; e–h, T-shaped triradiates; i, a T-shaped quadriradiate; j–n, ordinary monaxons; o, p, straight slender monaxons.

Text-fig. 98.



(b) *Monaxon Spicules*.—(1) The ordinary curved, barbed forms (text-fig. 97, figg. 22 *p*-22 *s*, p. 388) have the same characters as in *variabilis*; but they are usually short (60μ - 80μ in length), and though they may vary in size, they never reach quite the length which they do in *variabilis*; I have found none exceeding 300μ in length, and such dimensions are quite exceptional (text-fig. 98, fig. 26 *g*, p. 390). Further, they have a tendency to be less curved and slightly thicker, in proportion to their length, than in *variabilis*, and not to dwindle so much in thickness just below the lance-head as do the monaxons of the latter species; the features described are most marked in specimens in which the monaxons are for the most part short (fig. 22). The monaxons are always abundant and never absent, not even in the specimens identified by Haeckel as *Ascallis botryoides* (fig. 23), in which, therefore, they are supposed to be wanting. (2) The slender, straight, refringent monaxons are always present and have the same characters as in *L. variabilis* (figg. 22 *t*, 22 *u*). (3) The bayonet-shaped monaxons are not to be found in most specimens, but in some they are fairly common (figg. 25 *i*, 25 *j*), and show the same features as in *L. variabilis*.

(c) *General Remarks on the Species.*

Since this sponge was first named by Ellis and Solander in 1786, it was for many years the species to which all British Leucosolenias were referred, both in works dealing with sponges and in the labels of museums and collections, until Haeckel in 1872 first pointed out the distinctive characters of the species and gave a diagnosis of it. Haeckel, however, as has been pointed out, wrongly separated this species into two, one with, the other without monaxons, so that the characters which he ascribed to his unnecessary species *botrys* are those which should be given to *botryoides*. It is incomprehensible to me how Haeckel came to

Explanation of Text-fig. 98 (opposite).

Spicules of *Leucosolenia botryoides*.

Figg. 24 *a*-24 *i*. Spicules of a specimen from Portrush in Norman's Collection identified as *Ascandra botrys* by Haeckel. *a*, ordinary triradiate; *b*, ordinary quadriradiate; *c*, *d*, T-shaped triradiates; *e*-*h*, curved monaxons; *i*, straight slender monaxon.—Figg. 25 *a*-25 *j*. Spicules of a specimen from Heligoland in the Berlin Museum (No. 1777), showing the bayonet-like monaxons. *a*, triradiate, rather unusually slender; *b*, T-shaped triradiate; *c*, *d*, brackets; *e*, straight slender monaxon; *f*-*h*, curved monaxons, reaching a considerable length; *i*, *j*, bayonet-like monaxons.—Figg. 26 *a*-26 *l*. Spicules of a specimen from Liverpool in the Berlin Museum (No. 1763), showing the monaxons of great length. *a*, *b*, ordinary triradiates; *c*, quadriradiate; *d*, T-shaped triradiate; *e*, *f*, brackets; *g*-*k*, ordinary curved monaxons; *l*, bracket with gastral ray.—Figg. 27 *a*-27 *g*. Spicules of a specimen in the British Museum (Bowerbank Coll., 992), figured in Bowerbank, Brit. Spong. i. fig. 348 (see p. 164). *a*, ordinary triradiate; *b*, ordinary quadriradiate; *c*, T-shaped triradiate; *d*, *e*, ordinary monaxons; *f*, *g*, refringent monaxons.

make such a blunder*, since not only have I found monaxons well developed and abundant in his type specimen, No. 1 of my list below, but it is evident he himself saw them, since he found one of his usual "connexive" varieties, *Ascandra botryoides*.

Haeckel further distinguished two varieties, *ellisii* and *solanderii*, the former with the "apical ray of the quadri-radiates slightly curved, the lateral rays 7 or 8 times as long as thick, the unpaired angle 130° – 150° "; the latter with the "apical ray of the quadri-radiates straight, the lateral rays 5 or 6 times as long as thick, the unpaired angle 150° – 180° ." Since all these variations can be found in any specimen, Haeckel's two varieties may be struck out of the systematic list. As I have also pointed out above, there is nothing in Haeckel's description of *Ascandra nitida* to separate it from *botryoides*; *A. nitida* is, in fact, distinguished from *A. botrys* by the same characters practically as *Asclatis botryoides* var. *solanderii* from var. *ellisii*.

Of writers subsequent to Haeckel, Fristedt alone [9] seems to have penetrated Haeckel's mistake, since he calls the species *Ascandra botryoides*, as Haeckel ought to have done. Fristedt has, moreover, gone a step further, and has put *variabilis* as a synonym of *botryoides*, in which he has been followed by Vasseur [23]. I have been sorely tempted to follow Fristedt's lead also, and to place both forms as well-marked varieties of one species, for which, of course, the name *botryoides* would have to be maintained; the form ordinarily known as *botryoides* could then be called *botryoides* var. *typica*, and the other *botryoides* var. *variabilis*. As has been shown above, the difference between the two forms is purely one of degree in every respect. As regards spiculation, they are in complete agreement, every form of spicule occurring in the one being represented also in the other, and the special features of *botryoides* are merely an exaggeration of those of *variabilis*. As regards external form, *variabilis* occurs in a variety of situations and consequently varies in form; the fact that in *botryoides* the habits both of situation and growth are constant, is in itself highly suggestive of its being a form-variety adapted to a particular environment. Examination of the sponge brings to light a further very important fact, bearing directly upon the question under discussion, namely, that the thickened triradiate systems so highly characteristic of *botryoides* are nearly absent, or comparatively scarce, upon the basal network of tubes by which the sponge is attached to its support, but are greatly developed as a protecting and supporting layer upon the erect

* The only source I can suggest for Haeckel's error with regard to the monaxons of *botryoides* is the fact that Bowerbank also failed to see monaxons in this species, and considered their absence as one of the characters distinguishing it from his *Leucosolenia contorta*. If my notion be correct, this is a curious case of successive incarnations of an error, manifesting itself first in Bowerbank 1866, then in Haeckel 1872, and for the last time, let us hope, in Breitfuss 1898. A still more remarkable point in this history is the fact pointed out above, that the specimen from which Bowerbank described the spiculation of *botryoides* was really a specimen of *variabilis* (Haeckel), while the specimen of "*contorta*" from which he figured monaxons was in reality a specimen of *complicata*!

ocular tubes. The basal network thus completely resembles *variabilis* in its spiculation. For these reasons I should certainly place the two forms as varieties of one species were I now describing them for the first time.

I refrain at present, however, from taking the step of uniting the two forms, for the reason that they have long been kept distinct, and that they are generally very easily recognised and distinguished from each other. To call them one species, definite proof of relationship should be obtained. If, for instance, larvæ of a typical specimen of *botryoides* were cultivated and found to give rise to *variabilis* as well as to *botryoides*, according to the conditions of growth, no one could doubt any longer that the alleged two species were one. The experimental test of their relationship should not be difficult to obtain; but until it has been obtained, the two forms may be provisionally kept distinct under their old names, in spite of the fact that the diagnostic features of *botryoides* are purely relative as compared with *variabilis*.

(d) *List of Specimens examined.*

(a) From Canon Norman's Collection.

1. Dried specimen received from Johnston and sent by him to Haeckel for examination; figured by Haeckel, *Die Kalkschwämme*, pl. 9. fig. 10. (Haeckel's figure is, however, very much reconstructed, and does not bear a close resemblance to the original.) With a label in Haeckel's handwriting:—

"*Ascallis botryoides* Hkl.

"*Grantia botryoides* Johnston.

"*Leucosolenia botryoides* Bwbk.

"(vera!).

"Berwick Bay, Johnston."

Also with label by Norman:—

"*Leucosolenia botryoides*.

"Berwick Bay, Feb. 22nd, 1851.

"Dr. Johnston."

This most precious specimen is therefore one of Haeckel's types, and it shows clearly that, in a manner analogous to the case of *L. complicata* mentioned above, Haeckel overlooked the small but very abundant monaxons (see text-fig. 97, figg. 23 a-23 p, p. 388); that therefore the species should have been placed as *Ascandra botryoides* in his system; and that consequently the species *Ascandra botrys* H. should be struck out of the system, becoming a synonym of *L. botryoides*.

2. Dried specimen received from Dr. E. Perceval Wright, by whom it was sent to Haeckel for identification. With label in Wright's handwriting:—

"*Ascandra botrys*, Portrush, E. P. W.

"Specimens named by Haeckel."

(See text-fig. 98, figg. 24 a-24 i, p. 390.)

(b) From the British Museum.

3. Bowerbank Coll., 992. Dried specimen figured by Bowerbank, Brit. Spong. i. fig. 348; described p. 164. (See text-fig. 98, figg. 27 a-27 g, p. 390.)
 4. Bowerbank Coll., 980. Dried specimen, with label in Bowerbank's handwriting—" *Leucosolenia botryoides*, Guliot Caves, Sark, J. S. B."
 5. Bowerbank Coll., 981. Label in Bowerbank's handwriting—" *Leucosolenia botryoides* Bowk. Fowey. C. W. Peach. Very fine. O. C."
 6. Bowerbank Coll., 981. Label in Bowerbank's handwriting—" *Leucosolenia botryoides*, Scarborough, Bean."
 7. Register No. 47.9.7.109. Label " *Grantia botryoides*." Locality Berwick Bay, Johnston Collection.
 8. Register No. 47.9.7.107. Label as last: locality Bangor, County Down, Ireland, Johnston Collection.
 9. Register No. 87.6.25.4. Label "Calcareous Sponge, Shetland, E. M. Nelson, Esq."
- [The specimen No. 82.3.6.36, labelled " *Leucosolenia botryoides* B. Australia. ? sp.," in Carter's handwriting, is a totally distinct species.]

(c) From the Berlin Museum.

10. No. 1763, " *Ascartis botryoides*," Liverpool. A specimen of *L. botryoides* in which the monaxons attain an unusually large size, though the designation *Ascartis* implies their total absence!* (See text-fig. 98, figg. 26 a-26 l, p. 390.)
11. No. 1777. " *Ascandra botrys*," Heligoland. (See text-fig. 98, figg. 25 a-25 j.)

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* Breitfuss in his Catalogue [3] puts this specimen down as " *Leucosolenia botryoides*," and since the name *Leucosolenia* is used by him to denote Ascons in which monaxon spicules are lacking, it follows, either that he did not examine the specimen, or that he overlooked the very conspicuous monaxons.

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[Addendum.—Since the foregoing memoir was written and

read before the Zoological Society, a paper has appeared on the "Plymouth Marine Invertebrate Fauna" in the Journal of the Marine Biological Association (n. s. vii. 2, Dec. 1904), in which notes furnished by myself and Mr. Bidder are mixed up together with rather contradictory results (p. 185). Thus *Leucosolenia botryoides* is stated to occur "on the shore between tide-marks, not abundant except in certain localities (*E. A. M.*); rocks under the Hoe, in abundance (*G. P. B.*)."
L. variabilis is put down as "common everywhere in rock-pools between tide-marks (*E. A. M.*)."
 The fact is that Bidder has not recognised *variabilis* and *botryoides* as distinct, and, taking the characters of *botryoides* from Bowerbank (whose figured specimen of this species was really *variabilis*), Bidder has not unnaturally identified sponges as *botryoides* which should have been named *variabilis*. Bidder's note on the occurrence of *botryoides* should therefore be transferred to *variabilis*, and then it will be perfectly correct. The true *botryoides* is certainly very far from abundant on rocks under the Hoe; I doubt if it ever occurs there.]

2. Descriptions of Thirty-two new Species of *Halticinae* (Phytophagous Coleoptera) from South and Central America. By MARTIN JACOBY, F.E.S.

[Received November 25, 1904.]

List of the Species*.

<i>Lactica nicotinæ.</i>	Mexico.	<i>Acanthonycha costatipennis.</i>	Brazil.
" <i>decorata.</i>	Peru.	" <i>antennata.</i>	Brazil.
" <i>maculicollis.</i>	Peru.	<i>Sophrænella fulva.</i>	Amazons.
" <i>posticata.</i>	Peru.	<i>Blepharida flavocostata.</i>	Mexico.
" <i>discicollis.</i>	Peru.	" <i>multimaculata.</i>	Mexico.
" <i>rufobrunnea.</i>	Peru.	<i>Prasona peruviana.</i>	Peru.
" <i>baeri.</i>	Peru.	<i>Systema melanocephala.</i>	Peru.
" <i>argentinensis.</i>	Argentine.	" <i>argentinensis.</i>	Argentine.
<i>Agasicles vittata.</i>	Peru.	" <i>antennata.</i>	Amazons.
<i>Disonycha amazonica.</i>	Amazons.	<i>Pseudogona discoidalis.</i>	Argentine.
" <i>peruana.</i>	Peru.	" <i>militaris.</i>	Panama.
" <i>albicincta.</i>	Peru.	" <i>pallida.</i>	Costa Rica.
<i>Acanthonycha peruana.</i>	Peru.	<i>Oxygona amazonica.</i>	Amazons.
" <i>geniculata.</i>	Peru.	" <i>capitata.</i>	Peru.
" <i>dimidiata.</i>	Peru.	<i>Crepidodera longicornis.</i>	Peru.
" <i>stali.</i>	Costa Rica.	<i>Hippuriphila catharinæ.</i>	Brazil.

LACTICA NICOTINÆ, sp. n.

Flavous or fulvous, antennæ (the basal three joints excepted) black, head and thorax impunctate; elytra dark metallic blue or violaceous, finely punctured anteriorly, the posterior portion very obsoletely so.

Length 3-3½ millim.

Head impunctate, the frontal tubercles very distinct, carina short, not widened anteriorly, palpi robust; antennæ extending to

* The types of all the species described here are contained in the author's collection.

about the middle of the elytra, black, the lower three joints and the base of the fourth flavous, third and fourth joints equal, slightly longer than the second; thorax twice as broad as long, the sides nearly straight, with a narrow margin, the anterior angles obliquely thickened, the basal sulcus deep, straight, and bounded at the sides by equally deep perpendicular grooves, the surface impunctate, flavous or fulvous; scutellum fulvous; elytra without basal depression, the base distinctly, closely and somewhat regularly punctured, the punctuation gradually diminishing in size towards the apex; underside and legs fulvous, the tarsi sometimes piceous.

Hab. Mexico (found in tobacco), Jalapa.

This species was not known to me when I described the Central American Phytophaga for the Biolog. Centr.-Americana. It must be placed near *L. dives* Har. and *L. clara* Har., and is also closely allied to several other Mexican species of *Lactica*; but it differs from all in one or more details, notably in the distinct frontal tubercles, colour of the antennæ, and of the under side, and the fine elytral punctuation, &c. There are five specimens before me.

LACTICA DECORATA, sp. n.

Fulvous; antennæ, the underside and legs more or less black; thorax impunctate, with very deep sulcus; elytra minutely punctured, a transverse band at the base and a large spot near the apex metallic blue or greenish.

Var. *a.* Elytra metallic blue, the lateral margins narrowly and the apical one broadly fulvous.

Var. *b.* Antennæ, under side, and legs entirely fulvous.

Length $7-7\frac{1}{2}$ millim.

Head with a single puncture near each eye, the rest of the surface impunctate, frontal elevations absent, clypeus convex between the antennæ, labrum black; antennæ more or less piceous, sometimes nearly fulvous, robust, extending beyond the middle of the elytra, the second and third joints short, nearly equal, following joints elongate; thorax scarcely twice as broad as long, the sides straight, obliquely narrowed anteriorly, almost concave, the anterior angles strongly oblique, the basal sulcus slightly sinuate, very deep at the sides, less so at the middle, the surface entirely impunctate, pale fulvous; scutellum fulvous or piceous; elytra with an obsolete depression below the base, extremely finely and remotely punctured, fulvous, a transverse band at the base, not extending to the lateral margins and downwards to about the third portion of the elytra, and a transversely shaped shorter band or spot below the middle, metallic greenish or bluish; underside and legs black, abdomen more or less fulvous.

Hab. Peru.

A handsome species, somewhat allied in coloration in regard to the variety to *L. marginata* Clark, but the elytra of metallic coloration and the underside black. I have looked upon the

banded form as the typical one, and that in which the bands occupy the entire disc of the elytra as the variety. I cannot distinguish a specimen in any way from the others, having the antennæ, underside, and legs fulvous.

LACTICA MACULICOLLIS, sp. n.

Testaceous, the head and a spot at the anterior part of the thorax rufous; elytra elongate, scarcely perceptibly punctured, testaceous, a transverse band at the base rufous.

Length 4 millim.

Head entirely impunctate, rufous, frontal elevations absent, carina elongate, strongly convex, eyes very large; antennæ fulvous, long and slender, the third joint slightly longer and thinner than the second; thorax about one half broader than long, the sides straight, the basal sulcus broad and rather deep, the surface testaceous, impunctate, with a rufous spot at the middle of the anterior margin, anterior angles obtuse, thickened; scutellum testaceous; elytra not perceptibly punctured, even under a strong lens, elongate and parallel, testaceous, with a transverse rufous band at the base extending to the lateral margins, this band scarcely occupies a third portion of their length; underside and legs pale testaceous.

Hab. Peru.

Of less than half the size of *L. rufobasalis* Jac. and distinguished by the coloration of the head and thorax.

LACTICA POSTICATA, sp. n.

Head, the basal joints of the antennæ, the thorax, and the anterior femora flavous; elytra dark violaceous, finely punctured anteriorly; the posterior legs blackish.

Length 3 millim.

Head impunctate, the frontal elevations feebly raised; carina short, not widened in front; antennæ long and slender, black, the lower three and the base of the fourth joint flavous, third and fourth joints equal; thorax about twice as broad as long, the sides nearly straight, the anterior angles oblique, the basal sulcus straight and deep, bounded laterally by very deep perpendicular grooves, the surface impunctate, flavous; scutellum flavous; elytra without a trace of a basal depression, violaceous, with indistinct rows of fine punctures at the anterior portion, extremely sparingly and finely punctured near the apex; the breast and the anterior femora flavous; the abdomen, the posterior femora, and the tibiæ and tarsi piceous.

Hab. Peru.

Closely allied to *L. elegantula* Har. (Coleopt. Hefte, xiv. p. 16); but the frontal elevations of the head feeble, the latter without punctures, the third and fourth joints of the antennæ of equal length, the elytra without any basal depression and some fine punctures posteriorly, and the legs differently coloured. *L. boliviana* Jac. is of double the size and strongly punctured.

LACTICA DISCICOLLIS, sp. n.

Flavous, the head and the disc of the thorax piceous, the latter impunctate; elytra flavous, extremely minutely punctured.

Length 3 millim.

Head impunctate, nearly black; eyes very large, the diameter of each exceeding the intermediate space, frontal elevations obsolete; antennæ flavous, the second to the fifth joints gradually elongate; thorax one half broader than long, the sides straight, the anterior angles oblique, the basal sulcus and the perpendicular grooves very deep, the surface impunctate, piceous, all the margins narrowly flavous; scutellum piceous; elytra narrow and parallel, fulvous, scarcely perceptibly depressed below the base, very finely punctured and somewhat regularly arranged in rows, more irregularly and finely so near the apex; underside pale flavous, legs flavous.

Hab. Peru.

A small species, principally distinguished by the colour of the thorax. There are six specimens before me.

LACTICA RUFOBRUNNEA, sp. n.

Elongate and parallel, reddish-fulvous; the antennæ, the apex of the posterior femora, and the tibiæ and tarsi black; thorax impunctate, deeply sulcate; elytra extremely minutely punctured.

Length $5\frac{1}{2}$ millim.

Head with some deep punctures at the vertex, the frontal tubercles entirely obsolete, carina linear, short; antennæ extending to the middle of the elytra, black, the third and fourth joints equal, terminal joints slightly shorter; thorax scarcely one-half broader than long, distinctly narrowed anteriorly, the sides straight, the anterior angles oblique, the surface impunctate, with a broad transverse sulcus and deep perpendicular grooves; scutellum rather small; elytra elongate, without basal depression, extremely minutely and closely punctured; legs black; the base of the posterior femora and the underside fulvous.

Hab. Marcapata, Peru.

Allied to *L. clypeata* Baly; but smaller and shorter, of dark reddish colour, not testaceous, the head not punctured in front, the encarpæ obsolete, the antennæ entirely black, the thorax much less transverse with the sides straight, the anterior angles not dentiform.

LACTICA BAERI, sp. n.

Rufous; antennæ (the basal joint excepted) and the tibiæ and tarsi black, head and thorax impunctate; elytra very finely and rather closely punctured, metallic blue.

Length 5 millim.

Head impunctate, rufous, the frontal elevations small and transverse, carina elongate and narrow; eyes widely separated, moderately large; antennæ extending beyond the middle of the elytra, black, the basal joint and the base of the following two joints fulvous, the third joint distinctly shorter than the fourth,

the following elongate; thorax twice as broad as long, the sides rounded with comparatively broadly reflexed margins, the basal sulcus rather deep, the surface impunctate, rufous; scutellum fulvous; elytra nearly parallel, not depressed below the base, the shoulders prominent, the surface finely and closely punctured, the punctures distinct to the apex; underside and legs rufous, the tibiæ at their outer edge and the tarsi black.

Hab. Prov. Huallaga, Rio Mixiollo, Peru (*G. A. Baer*). Collection M. Clavareau and my own.

This species of *Lactica* is allied to *L. dives* Har.; but differs from it in the black tibiæ, the rufous coloration, and blue not violet elytra, and from the other species of the genus in the same differences of coloration and the impunctate head; in one of the specimens the head has a distinct fovea at the middle of the vertex, which is wanting in the other or is scarcely indicated.

LACTICA ARGENTINENSIS, sp. n.

Flavous, antennæ and legs black; head and thorax impunctate; elytra dark violaceous, microscopically punctured.

Length $5\frac{1}{2}$ millim.

Of broad and nearly parallel shape, the head very broad and convex, without scarcely an indication of tubercles or carina; the clypeus broad, convex, scarcely separated from the face; labrum and palpi black; antennæ robust, black, the second and third joints short, nearly equal, fourth and following joints about one half longer; thorax twice as broad as long, narrowed anteriorly, the anterior angles oblique, the basal sulcus deep as well as the perpendicular lateral grooves, the surface impunctate, pale flavous; scutellum triangular, flavous; elytra convex, without trace of a basal depression, dark violaceous blue, remotely and extremely minutely punctured; underside flavous, legs black.

Hab. Tucuman, Argentine Rep.

This is a well distinguished species on account of the broad and convex shape of the head, which nearly forms an uninterrupted smooth surface. I received two specimens of this insect from Mr. C. Bruch, of the La Plata Museum.

AGASICLES, gen. nov.

Body elongate and glabrous; antennæ filiform, the third and following joints elongate, terminal ones shorter; thorax as long as broad, the sides straight, the surface without sulcus; elytra wider at the base than the thorax, obsoletely punctured, their epipleuræ broad; legs stout, the posterior femora strongly incrassate, their tibiæ mucronate, the other tibiæ unarmed, the first joint of the posterior tarsi as long as the following joints together, claws appendiculate; prosternum narrow; mesosternum elongate, rather broad, deeply triangularly emarginate at the base; anterior coxal cavities open; pygidium not covered by the elytra, convex, broadly rounded.

Amongst the genera of *Halticinae* with open coxal cavities and a non-sulcate thorax, I know of none in which the latter part is of similar shape, that is as long as broad; this character and the general elongate shape, which resembles somewhat a *Donacia*, will help to distinguish the genus.

AGASICLES VITTATA, sp. n.

Black, the lower three joints of the antennæ fulvous, thorax with an æneous gloss; elytra nearly impunctate, flavous, the sutural and lateral margins as well as the apex and a longitudinal stripe at the disc, abbreviated at each end, black.

Length 6 millim.

Head deeply and irregularly punctured, æneous, the frontal elevations feebly marked, subquadrate; clypeus broad, raised at the middle, triangular; palpi fulvous, the terminal joint small, acutely pointed; antennæ extending to the middle of the elytra, black, the lower three joints fulvous, third joint shorter than the fourth, both thickened at the apex, the following joints shorter; thorax with straight sides, the angles obtuse, the surface flat, dark æneous, extremely minutely granulate and punctured; scutellum broadly rounded at the apex, coloured like the thorax; elytra narrow and parallel, extremely minutely punctured, a sutural and lateral narrow stripe widened into a spot at the apex and a longitudinal band at the middle, not extending to the base or the apex, greenish-black, the rest of the surface flavous; under side and legs black; last abdominal segment deeply longitudinally sulcate, its apex strongly emarginate.

Hab. Prov. Huallaga, Rio Mixiollo, Peru.

Of this species a single specimen is contained in my collection which I received from M. Clavareau at Brussels, another is in that gentleman's possession. The specimen before me is probably a male, judging from the structure of the last abdominal segment and the prominent pygidium.

DISONYCHA AMAZONICA, sp. n.

Head, the breast, and the legs pale piceous; thorax testaceous, impunctate; elytra minutely punctured, black, the lateral margins and a narrow transverse band at the middle flavous.

Length 8 millim.

Head impunctate, the vertex piceous, the lower portion testaceous; eyes large, oblong, with a single deep puncture near their inner margins, frontal tubercles obsolete; clypeus strongly convex; labrum black; antennæ obscure fulvous, the basal joint flavous, third joint shorter than the fourth; thorax twice as broad as long, the sides feebly rounded, narrowly margined, the anterior angles obliquely rounded, the posterior ones acute, oblique, the surface impunctate, shining, obsoletely transversely sulcate near the base; scutellum black; elytra extremely finely punctured, black, this colour interrupted at the middle by a narrow transverse

flavous band, and at the sides by the flavous lateral margins; abdomen testaceous, breast and legs pale piceous.

Hab. Amazons.

The coloration of this species entirely resembles that of many members of the genera *Oedionychis* and *Asphæra*; but the shape of the thorax and the non-inflated claws, as well as the elongate metatarsus of the posterior legs, prove the insect to belong to *Disonycha*.

DISONYCHA PERUANA, sp. n.

Fulvous, the antennæ, tibiæ, and tarsi black, testaceous above; the head with one, the thorax with five black spots; elytra impunctate, a narrow sutural and discoidal stripe and the lateral margins black.

Length 7 millim.

Head impunctate, testaceous with a central black spot, frontal elevations feebly raised; antennæ black, not extending to the middle of the elytra, the basal two joints fulvous below, third joint slightly shorter than the fourth; thorax one-half broader than long, the sides nearly straight, the anterior angles thickened, the posterior ones strongly oblique, the surface impunctate, testaceous, with five obsolete piceous spots, four anteriorly and one elongate at the middle; scutellum black; elytra impunctate, flavous, narrowly edged with black, and a similar narrow stripe at the middle which does not quite extend to the apex, elytral epipleuræ testaceous within; under side testaceous, femora darker, tibiæ and tarsi black.

Hab. Peru.

A proportionately large-sized species, and differing from most of its congeners in having the lateral black elytral stripes not placed close to but at the actual margins; the narrow shape of the stripes and the entirely impunctate elytra will assist further in the determination of the species.

DISONYCHA ALBICINCTA, sp. n.

Black; thorax pale flavous, impunctate; elytra bluish black, a very narrow transverse band before the middle, another near the apex, connected at the sides by a longitudinal stripe, white.

Length 6 millim.

Head with a few deep punctures near the eyes, black, very shining, frontal elevations absent, carina very narrow; antennæ black, the basal joint flavous below, fourth joint much longer than the third, apical joint extending beyond the middle of the elytra; thorax scarcely twice as broad as long, the sides straight, narrowly marginate, the anterior angles thickened, obtusely rounded; the disc impunctate, with a very obsolete transverse groove near the base, pale yellow, scutellum black; elytra microscopically punctured, elongate and parallel, bluish black, metallic, with two very narrow transverse bands connected at the lateral margins by an equally narrow longitudinal stripe, the first band

immediately before the middle, the second near the apex ; under-side and legs black.

Hab. Peru and Bolivia.

A very distinct species, well distinguished by the narrow white elytral bands connected at the sides. Seven specimens are contained in my collection.

ACANTHONYCHA PERUANA, sp. n.

Elongate and parallel, reddish fulvous, antennæ and legs black, posterior femora fulvous at the base ; thorax impunctate ; elytra metallic green, finely punctured and wrinkled.

Length 5 millim.

Head impunctate, fulvous, shining, the frontal tubercles strongly developed, rather broad ; antennæ very slender, extending beyond the middle of the elytra, fulvous, the second joint piceous, third one-half shorter than the fourth joint ; thorax not broader than long, the sides nearly straight and forming a slight angle before the middle, anterior angles slightly produced outwards, the disc very obsoletely transversely sulcate near the base, reddish fulvous, very shining and impunctate ; scutellum fulvous, broad ; elytra wider at the base than the thorax, parallel, very narrowly margined, metallic greenish, the surface very finely and closely punctured and transversely wrinkled, the extreme lateral margins and the epipleuræ fulvous, the latter very broad anteriorly ; below and the legs pale fulvous, the anterior tibiæ rather darker.

Hab. Peru.

Acanthonycha was established by me in the Biolog. Centr.-Amer. for a species placed by Baly in *Pelonia* (*P. elegantula*), from which it differs very materially in the structure of the thorax and other details ; the species described here differs from that of Baly by the sculpturing of the elytra, which are finely wrinkled instead of smooth.

ACANTHONYCHA GENICULATA, sp. n.

Reddish fulvous, the antennæ and legs (the base of the posterior femora excepted) black, thorax impunctate ; elytra dark blue, finely rugose and punctured.

Length 5 millim.

This species agrees in most structural details with the preceding one, of which it may possibly be a variety only ; but the antennæ are more robust, the joints less elongate and entirely black ; this is also the case with the legs, excepting the basal greater portion of the posterior femora which is fulvous, the colour of the elytra also is dark blue instead of green. There are two exactly similar specimens before me.

Hab. Peru.

ACANTHONYCHA DIMIDIATA, sp. n.

Fulvous ; the antennæ, tibiæ and tarsi, the posterior legs and the abdomen black ; thorax with a deep transverse sulcus ; elytra

minutely punctured, the posterior portion metallic blue, the anterior one fulvous.

Length 7 millim.

Head produced, impunctate, fulvous, the frontal elevations strongly raised, tuberculiform; clypeus thickened, flavous; antennæ extending to two-thirds the length of the elytra, black, fourth and following joints very elongate, the third shorter; thorax subquadrate, the sides distinctly angulate before the middle, the anterior angles acute, the disc with a deep transverse sulcus near the base and a depression anteriorly (accidental?) impunctate, fulvous; elytra extremely minutely punctured, fulvous, with a slight purplish gloss, the posterior portion, from immediately below the middle, bright metallic blue; elytral epipleuræ very broad, fulvous anteriorly, blue at the posterior half; underside fulvous, the abdomen and the posterior legs as well as the tibiæ and tarsi black.

Hab. Peru.

Excepting in the deep thoracic sulcus, this species (of which I possess a single, apparently female, specimen) agrees in all structural details with the others, but is much larger and well distinguished by its coloration; thoracic feeble sulci can also be perceived in the other species of this genus.

ACANTHONYCHA STALI, sp. n.

Fulvous; the antennæ (the basal joint excepted) and the tibiæ and tarsi black; thorax impunctate, shining; elytra very minutely punctured, rather flattened.

Length 6 millim.

Head impunctate, shining; antennæ extending to the middle of the elytra, black, the basal joint fulvous, third joint much shorter than the fourth; thorax subquadrate, of the same shape and smooth as in the allied species, more transverse however, and distinctly angulate before the middle in the female insect; elytra obsoletely depressed below the base and longitudinally so within the shoulders, very finely and closely punctured, the posterior femora rather strongly incrassate.

Hab. Tucurrique, Costa Rica.

Rather larger than the other species of the genus, the antennæ with fulvous basal joint, the fourth joint proportionately longer, the elytra differently coloured, and the posterior femora more strongly incrassate. I cannot discover any sexual characters in the structure of the last abdominal segment, which seems the same in all the specimens before me, but the shorter antennæ and more transversely shaped thorax, with its strongly angulate sides in one of the specimens, are probably the female characters.

ACANTHONYCHA COSTATIPENNIS, sp. n.

Fulvous; the antennæ (the basal joints excepted) and the tibiæ and tarsi black; thorax subquadrate, impunctate; elytra dark blue,

closely punctured, the sides with a longitudinal costa, preceded by a sulcus (♀).

Length $5\frac{1}{2}$ millim.

Head deeply inserted, the frontal elevations strongly raised, clypeus with an acute carina between the antennæ, the latter black, the basal three joints fulvous, the third joint one-half shorter than the fourth, the following joints slightly widened; thorax subquadrate, of the same shape as usual, fulvous, the base with an obscure transverse depression, another one still less distinct being placed near the anterior margin; scutellum fulvous; elytra closely and finely punctured, with an acutely raised costa from the shoulders to below the middle and preceded by a longitudinal sulcus; posterior femora but slightly thickened, tibiæ and tarsi black.

Hab. Santa Catarina, Brazil (*Fruhstorfer*).

At once distinguished from the other species of the genus by the costæ of the elytra in connection with the close punctuation, their epipleuræ are broad but the prosternum is very narrow. The two specimens before me are probably females, and in the male the elytral costæ may be absent.

ACANTHONYCHA ANTENNATA, sp. n.

Fulvous; antennæ robust, black, the basal three joints fulvous; thorax impunctate; elytra dark blue, very finely and closely punctured, their epipleuræ fulvous; tarsi piceous.

Length 4 millim.

Of this species only a single male specimen is before me, which may possibly be the male of *A. costatipennis*; but the antennæ differ so much from those of that insect and of the other species of the genus that I must look upon the species as distinct: these organs are proportionately short and stout, the third joint is one-half shorter than the fourth and the latter and the following joints are triangularly elongate, but not filiform; the under side is clothed with fine yellow pubescence, the legs are more robust than usual and the tarsi rather widened. The species can only be compared to those in which the elytral punctuation is distinct, but the short antennæ will distinguish it from any of them.

Hab. Santa Catarina, Brazil.

SOPHRAENELLA, gen. nov.

Ovate, convex; antennæ short, gradually transversely widened, the basal joint club-shaped, the second very short, third joint triangularly elongate, the following joints transversely subquadrate, terminal joint short, ovate; eyes reniform, deeply and broadly emarginate; palpi with the penultimate joint strongly incassate; thorax nearly three times broader than long, the sides narrowly margined, the anterior angles oblique, the surface without sulcus; scutellum broadly triangular; elytra convex, broadly ovate, their epipleuræ moderately broad at the base,

disappearing below the middle; legs short and robust, the posterior femora strongly incrassate, their tibiae with a short spur, broadly channelled near the apex, tarsi short and broad, claws appendiculate; prosternum narrowly elongate, mesosternum subquadrate, the anterior cotyloid cavities open.

I propose this genus for a robust-looking species of fulvous coloration, which, in the short, transverse joints of the antennae, resembles much the genus *Sophraena* Baly, but which may be at once distinguished by the elongate and reniform shape of the eyes; there is also a difference in the proportionate length of the joints of the antennae. In *Nephrica* Har. the eyes are likewise kidney-shaped, but not to such an extent as in the present genus, and the antennae are filiform. As to *Sophraena*, Baly did not mention the state of the anterior cotyloid cavities when he described the genus; Chapuis in his 'Genera' has placed the species near *Oxygona* and states that the cavities are closed. As the opposite is the case in this genus, the latter must find its place near *Rhopalotoma* Clark, but the genus stands isolated in that group by the shape of the antennae.

SOPHRAENELLA FULVA, sp. n.

Fulvous; the antennae (the basal joint excepted) black; thorax finely and closely punctured; elytra strongly convex, punctured like the thorax.

Length 7 millim.

Head very flattened (like that of a *Cryptocephalus*), impunctate with the exception of a single puncture near the eyes, the latter occupying nearly the entire sides of the head; frontal elevations absent; antennae only extending to the base of the elytra, black, the basal joint entirely and the second one partly fulvous; thorax nearly three times broader than long, the sides nearly straight, narrowed anteriorly, the anterior angles oblique, the surface closely and finely punctured, posterior margin rather rounded and produced at the middle; scutellum broadly ovate; elytra not wider at the base than the thorax, very closely and scarcely more strongly punctured than the latter.

Hab. Amazons.

The resemblance of the head to that of a species of *Cryptocephalus* is very striking, if the antennae are not considered.

BLEPHARIDA FLAVOCOSTATA, sp. n.

Flavous, the antennae, tibiae, and tarsi black; thorax with five black spots, finely punctured; elytra closely and strongly punctured, fuscous, each elytron with five narrow, flavous, longitudinal costae; sides of the breast and abdomen black.

Length 9 millim.

Head with the frontal elevations broad and strongly raised, the carina linear; antennae extending to the middle of the elytra, black, the third and fourth joints equal, the terminal joints shorter; thorax transverse, about twice and a half broader than long, the

sides straight, the posterior angles oblique, the disc very finely and irregularly punctured, flavous, with five black spots (2, 3), those near the posterior angles larger and of transverse shape; scutellum broadly triangular, the base fuscous, clothed with fine yellow hairs, the apex fulvous; elytra widened towards the middle, very broad, of fuscous colour, closely, strongly, and somewhat rugosely punctured, with five flavous longitudinal costæ on each elytron, placed at equal distances, the first subsutural one short and extending to the suture at its posterior end, the third and fourth costæ joined at the apex; the femora and the rest of the under side flavous, the sides of the breast and of the abdomen, the tibiæ and tarsi black, claws bifid.

Hab. Cuernavaca, Mexico (*Dr. A. Fenzles*).

I only know two specimens of this species, one of which I received from M. Clavareau at Brussels.

BLEPHARIDA MULTIMACULATA, sp. n.

Fulvous; thorax very finely and sparingly punctured; elytra dark fulvous or piceous, the suture more or less fulvous, closely longitudinally costate, the interstices strongly punctured, the costæ with numerous small whitish spots.

Length 4 millim.

Head impunctate, fulvous; antennæ extending slightly beyond the middle of the elytra, fulvous; all the joints, with the exception of the second, elongate, the third slightly shorter than the fourth joint; thorax of equal width, twice as broad as long, the sides feebly rounded; the surface covered with a few fine punctures, irregularly distributed; scutellum piceous; elytra dark chestnut-coloured or piceous, strongly and closely punctured in rows, the interstices longitudinally costate, to the number of about ten on each elytron, with numerous small round yellowish-white spots, irregularly placed and different on each elytron; legs flavous, the sides of the breast blackish.

Hab. Atlixco, Tepetlapa, Mexico.

This species, of which I received several specimens some time ago from M. Clavareau, was not known to me at the time of the publication of the *Biologia Centr.-Amer.*; it resembles greatly in coloration several Eastern species, and must not be confounded with *B. marmorata* Jac., likewise from Mexico, as in that insect the elytra are not costate, the colour is black, and the spots much fewer in number.

PRASONA PERUVIANA, sp. n.

Greenish-testaceous, antennæ fulvous, head with a black spot; thorax impunctate, transversely sulcate; elytra closely punctured, each elytron with two elongate spots at the base and a round one at the apex, black.

Length 7 millim.

Head broad, impunctate, greenish, the vertex with a black spot; antennæ about two-thirds the length of the body, pale fulvous,

the third and fourth joints equal; thorax twice as broad as long, the sides subangularly rounded before the middle, constricted near the base, the anterior angles blunt, the posterior ones acute, the surface with a rather deep, transverse, sinuate sulcus near the base, extending to the sides, the disc impunctate; elytra wider at the base than the thorax, transversely depressed below the latter, very closely and distinctly punctured, the punctures somewhat regularly arranged in rows, the ground-colour of a pale greenish-testaceous, the base with two elongate black spots, one near the margin, the other near the scutellum and extending nearly to the middle of the elytra, another round black spot is placed near the apex; underside and legs coloured like the upper surface.

Hab. Marcapata, Peru.

I possess five similarly marked specimens of this distinct species.

SYSTEMA MELANOCEPHALA, sp. n.

Flavous, the head, the terminal joints of the antennæ, and the breast black; thorax impunctate, flavous; elytra extremely minutely punctured, flavous, the suture at the base, a humeral spot and a transverse band near the apex black.

Length 8 millim.

Head impunctate, very shining, black, the frontal elevations and the clypeus flavous; antennæ extending to the middle of the elytra, flavous, the apical four joints black, third joint one-half shorter than the fourth; thorax one-half broader than long, the sides nearly straight, the anterior angles thickened, posterior ones distinct, the surface very obsoletely sulcate near the base, extremely minutely punctured, flavous, shining; scutellum black; elytra punctured like the thorax, flavous, a narrow sutural stripe at the base and a subtriangular humeral spot as well as a transverse band near the apex black, this band extends down the suture to the apex, its posterior edge is consequently deeply concave; underside and legs flavous, the breast and the tarsi black.

Hab. Marcapata, Peru.

A single specimen is contained in my collection. This species much resembles in its elytral markings certain forms of *Diabrotica*.

SYSTEMA ARGENTINENSIS, sp. n.

Testaceous, sides of the thorax with a black stripe; elytra minutely punctured, the suture, a submarginal, medially widened stripe, and a spot at the base and near the apex black.

Length 5 millim.

Head broad, pale fulvous, microscopically punctured, without any tubercles or ridges; clypeus pale flavous, deflexed; antennæ not extending to the middle of the elytra, testaceous, the third and fourth joints elongate and equal, terminal joints distinctly shorter; thorax subquadrate, about one-half broader than long, with a very obsolete transverse depression near the base, impunctate, the sides with a narrow longitudinal black stripe; elytra very finely punctured, testaceous, a sutural band, not extending

to the apex, a stripe, widened medially, near the lateral margins and likewise abbreviated posteriorly, black, this stripe connected at its apex with an elongate spot, forming a hook, another small black spot is placed near the scutellum; under side and legs testaceous.

Hab. Prov. Tucuman, Argentine Rep. (*C. Bruch*).

Of different elytral marking than any other species of the genus described. In the collection of the La Plata Museum and my own.

SYSTEMA ANTENNATA, sp. n.

Flavous, the apical joints of the antennæ black; thorax impunctate; elytra fulvous, extremely minutely punctured.

Mas. Antennæ robust, the basal joint strongly thickened, deeply concave above. *Fem.* Antennæ of normal shape.

Length 5 millim.

Mas. Head impunctate, with a short central groove, the frontal elevations flat and broad, carina linear; antennæ stout, the lower six joints flavous, the others black, basal joint short and very thick, deeply hollowed out at the apex, the latter produced into a point, second joint short, third one-half longer, the following joints more elongate; thorax nearly twice as broad as long, the sides rounded, the disc very obsoletely transversely sulcate near the base; elytra wider at the base than the thorax, reddish-fulvous, extremely minutely punctured, their epipleuræ broad and distinct to the apex; under side and legs flavous, posterior femora rather strongly incrassate, their tibiæ with a short spine; metatarsus as long as the following joints together, claws appendiculate; prosternum very narrow, the cotyloid cavities closed.

Hab. Amazons.

The structure of the antennæ in the male differs from that of any other species known to me; in the female, however, the basal joint is long and slender and the following two joints are both short and equal and of flavous colour only, all the others being black: no other differences of importance are present.

PSEUDOGONA DISCOIDALIS, sp. n.

Fulvous; the antennæ, the apex of the posterior tibiæ, and the tarsi black; thorax impunctate; elytra parallel, impunctate, black, a sutural band, transversely widened before the middle and near the apex, flavous.

Length 4 millim.

Head impunctate, fulvous, with a deep fovea between the eyes, base of the clypeus very broad between the antennæ; eyes large and round; labrum and palpi piceous, the latter slender; antennæ filiform, black, the basal joint more or less fulvous, fourth and following joints slightly triangularly widened, not longer than the third joint which is more slender, terminal joint extending to the middle of the elytra; thorax about one-half broader than long, the lateral margins slightly rounded at the middle and constricted at the base, the anterior angles obtuse; the disc transversely

convex, impunctate, fulvous; scutellum black; elytra with a few minute punctures at the base, rest of the surface impunctate, the sides broadly black, the sutural portion in shape of a flavous longitudinal band which is transversely widened below the base and near the apex; underside and legs pale fulvous; the apex of the posterior femora and the tarsi black, the posterior metatarsi elongate, claws appendiculate; anterior cotyloid cavities closed.

Hab. Cordova, Argentine Rep. (*C. Bruch*).

I received two exactly similar specimens of this species from Mr. Carlos Bruch.

PSEUDOGONA MILITARIS, sp. n.

Head, the lower joints of the antennæ, and the tibiæ and tarsi black; thorax fulvous, impunctate; elytra opaque, black; a small spot near the scutellum, a transverse band at the middle and the apex flavous or whitish; femora and abdomen fulvous.

Length $5\frac{1}{2}$ millim.

Head entirely black, very shining and impunctate, frontal elevations transverse, short; antennæ extending beyond the middle of the elytra, black, the apical four joints fulvous, these rather stouter than the rest of the joints; thorax of the same shape and colour as in the preceding species, shining and impunctate, scutellum black; elytra with a shallow transverse depression below the base, opaque, extremely minutely punctured, black, the lateral margins, a narrow small spot near the scutellum, a transverse narrow band at the middle and the apex broadly, pale fulvous; the breast, tibiæ, and tarsi black.

Hab. Panama.

This species must not be mistaken for *P. panamensis* Jac., which it resembles somewhat in its markings; but the last-named species has very shining elytra without basal depression, set with two large fulvous spots placed at the base, whilst the posterior fulvous band is placed below, not at the middle; the antennæ also have the last three joints flavous instead of four.

PSEUDOGONA PALLIDA, sp. n.

Testaceous, the head, the antennæ (more or less) and the tibiæ and tarsi black; thorax fulvous, impunctate; elytra extremely minutely punctured, testaceous, an elongate humeral spot black.

Var. Elytra without spots, the middle with an obsolete transverse flavous band.

Length 5 millim.

Of elongate, subcylindrical shape; the head impunctate, black; the clypeus flavous; eyes very large; palpi filiform, pale; antennæ extending to the middle of the elytra, flavous, the intermediate joints more or less black, the apical three joints always pale, the third and following joints nearly equal in length; thorax subquadrate, scarcely broader than long, the sides rounded, the angles not prominent; the disc convex, very shining, fulvous, impunctate; scutellum small; elytra with indistinct rows of minute punctures,

only visible under a strong lens, pale testaceous or flavous, the shoulders with an elongate black spot; femora robust, flavous like the under side, tibiæ partly or entirely as well as the tarsi black.

Hab. Tucurrique, Costa Rica.

Of the genus *Pseudogona*, established by me in the *Biologia Centr.-Amer.*, four species are now known; they are neat-looking insects, and distinguished by the subquadrate thorax without sulcus in connection with the closed cavities, &c. The present species seems variable in regard to coloration; the entirely flavous underside and the markings of the elytra (when present) distinguish the species.

OXYGONA AMAZONICA, sp. n.

Flavous; the antennæ piceous, thorax impunctate; elytra extremely minutely punctured, a transverse band at the base and an elongate spot near the apex obscure piceous.

Length 6 millim.

Head impunctate, with a central fovea, clypeus broad between the antennæ, deflexed anteriorly; antennæ extending to the middle of the elytra, piceous, the third and following joints nearly equal; thorax more than twice as broad as long, of usual shape, the sides slightly rounded, with a narrow margin, the anterior angles oblique, the disc impunctate, flavous; elytra with a slight depression below the base, impunctate, with the exception of a few fine punctures at the base, the latter with a narrow transverse piceous band, the apex with a similar elongate spot not extending to the margins; underside and legs flavous, the apex of the posterior femora and the tarsi sometimes stained with piceous.

Hab. Amazons.

I possess two exactly similar specimens, which differ from their congeners in the design of the elytra.

OXYGONA CAPITATA, sp. n.

Testaceous, the base of the head, the thorax, and the scutellum obscure piceous, thorax impunctate; elytra finely and closely punctured, antennæ pale piceous.

Length $5\frac{1}{2}$ millim.

Head impunctate, the vertex pale piceous, the lower portion of the face flavous; frontal elevations strongly raised, pear-shaped; clypeus flattened anteriorly; antennæ extending to two-thirds the length of the elytra, pale piceous, the third and fourth joints elongate, equal; thorax twice as broad as long, the sides very slightly constricted at the base, the anterior angles slightly produced outwards, thickened, the surface rather convex, pale piceous, impunctate; scutellum piceous; elytra very finely and rather obsoletely punctured, much paler than the thorax; under side and legs coloured like the elytra.

Hab. Peru.

There are two exactly similarly coloured specimens before me,

which I must separate from *O. luridus* Cl. and *O. simplex* Clark, of which I have compared the types in the British Museum. The head and thorax differ in coloration from these, the head in the present species having no fovea at the centre, the anterior angles of the thorax are dentiform and produced, not obsolete as in *O. simplex*, and the general size is much smaller.

CREPIDODERA LONGICORNIS, sp. n.

Oblong-ovate, black, the basal joints of the antennæ and the legs fulvous; thorax subquadrate, minutely punctured, deeply sulcate; elytra convex, finely punctate-striate; antennæ very long; legs robust.

Length 4 millim.

Of broadly ovate shape, the head impunctate, black; frontal elevations broad, trigonate, strongly raised; clypeus convex between the antennæ, its anterior margin of the shape of a semicircular ridge; antennæ nearly extending to the apex of the elytra, black, the lower three joints fulvous, the third joint longer than the others, basal joint thickened, elongate-cylindrical, terminal joint about as long as the third; thorax convex, but slightly broader than long, the sides rounded at the middle, the angles not produced, the disc microscopically punctured, with a deep transverse sulcus near the base, bounded at the sides by a perpendicular groove; elytra wider at the base than the thorax, widened towards the middle, with a distinct basal transverse depression, the shoulders prominent, the surface finely punctate-striate, black and shining, the interstices flat; legs robust and short, fulvous, all the femora thickened, the tibiæ strongly widened at the apex, the first joint of the tarsi broadly flattened.

Hab. Peru.

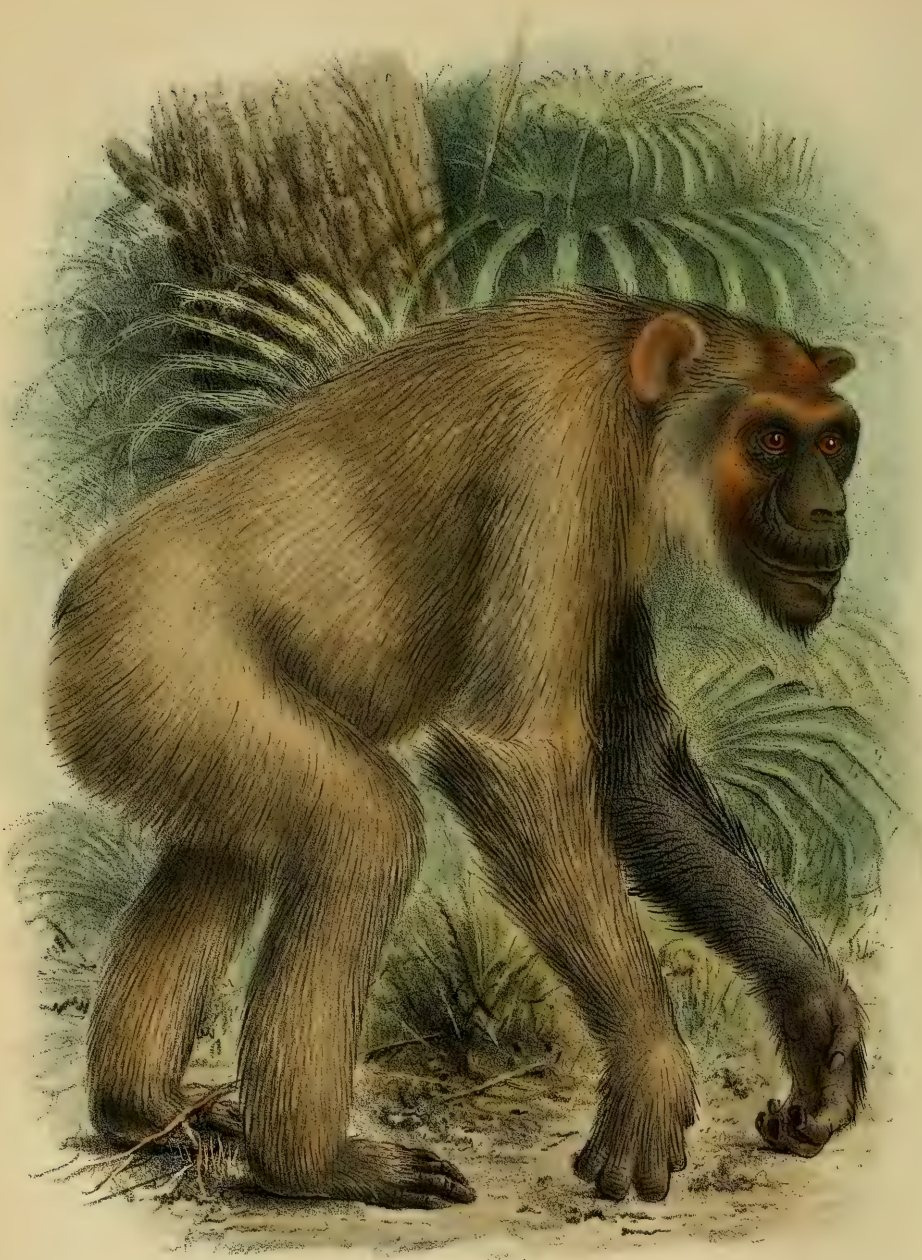
I know only a single specimen of this species, which, by its robust legs, the long antennæ, and general coloration, is well distinguished. In the last respect, the species resembles evidently *C. peruviana* Harold (*Deutsche ent. Zeitsch.* 1877, p. 130), but it is much larger, the antennæ are differently coloured, and the elytral punctuation is distinct to the apex.

HIPPURIPHILA CATHARINÆ, sp. n.

Black below, above greenish-æneous, the basal joints of the antennæ fulvous; thorax very strongly punctured, with a feeble transverse sulcus; elytra strongly punctate-striate, the base with a transverse depression.

Length 2 millim.

Short, convex, and ovate; the head impunctate, æneous, a single punctiform impression above each eye, the latter rather large, from the upper margins of which a deep narrow groove extends obliquely to the base of the antennæ, both grooves meeting at the centre; clypeus convex between the antennæ, widened anteriorly;



H. Grönvold. del. et lith.

Mintern Bros. imp.

SIMIA VELLEROSUS (GRAY)
(very old male)

antennæ rather short and robust, black, the lower three joints fulvous, the second and third joints small, equal, the terminal six joints rather strongly widened, but longer than broad; thorax scarcely twice as broad as long, the sides nearly straight, obliquely angulate before the middle, very narrowly margined, basal margin oblique at the sides, rather strongly produced towards the scutellum, preceded by a shallow transverse sulcus which is bounded at the sides by a deep perpendicular groove, the surface rather convex, somewhat closely and strongly punctured; elytra with a shallow depression below the base, the shoulders rather prominent and smooth, the surface strongly and regularly punctate-striate, the interstices impunctate and flat; under side and legs black, base of tibiæ and the tarsi more or less fulvous, prosternum narrowly elongate; with a longitudinal shallow sulcus.

Hab. Santa Catarina, Brazil.

The short, ovate shape of this species, short and rather robust antennæ, and the produced basal margin of the thorax at the middle agree best with the species at present placed in *Hippuriphila* instead of *Crepidodera* proper; four specimens are contained in my collection.

3. Notes on Anthropoid Apes.

By the Hon. WALTER ROTHSCHILD, Ph.D., F.Z.S.

[Received December 13, 1904.]

(Plate XXIV.* and Text-figures 99-117.)

Although, from the earliest times, beginning with Hanno's *Gorillæ*, we find the writings of observers of nature filled with accounts of hairy wild men, and, in later days, many descriptions by zoologists of anthropoid apes, it was only after the appearance of Du Chaillu's book that universal attention was turned to these creatures.

Prior to 1870, several so-called species both of *Gorilla*, *Anthropopithecus*, and *Simia* auct. had been established, but until lately the majority of zoologists maintained that there was only one rather variable species each of *Gorilla*, *Chimpanzee*, and *Orang-Outan*. Professor Matschie's articles on the genus *Gorilla* (Sitzungsb. Ges. naturf. Freunde, 1903, pp. 253-259, and 1904, pp. 45-53) and his articles on the species and races of *Chimpanzee* (Sitzungsb. Ges. naturf. Fr. 1900, pp. 77-85, and 1904, pp. 55-69) have, however, once more aroused the greatest interest in the question of the true status of our knowledge of the anthropoid apes. In the first place, Professor Matschie insists, and, I believe, rightly, that the Gibbons (*Hylobates*) should form a separate

* For explanation of the Plate, see p. 440.

family—Hylobatidæ—and not be united with the great man-like apes. Although I propose to deal mainly with the Chimpanzees, I must allude to the genera *Gorilla* and *Pongo*, as I differ slightly from Professor Matschie.

In the first place, Professor Matschie himself gives only

TABLE of Comparative Measurements
of the Skulls of *Gorilla gorilla* and *G. gorilla matschiei*.

<i>Hinder surface of Head:</i>		
Greatest breadth at the Mastoid processes.....	144, 147, 155, 162 mm.	170 mm.
Breadth above the Mastoid processes	116, 120, 121, 123 mm.	163 mm.
Length from centre of Crista lambdoidea to basal edge of Foramen magnum	90, 100, 101, 103 mm.	109 mm.
<i>Foramen magnum:</i>		
Length	30, 32, 32, 34 mm.	40 mm.
Breadth	26, 28, 29, 30 mm.	35 mm.
Breadth on outside of Occipital condyles	45, 45, 51, 51 mm.	59 mm.
<i>Basioccipital:</i>		
Length from front edge of Foramen magnum	45, 45, 46, 49 mm.	35 mm.
<i>Occipital condyles:</i>		
Breadth at base	31, 32, 35, 38, 39 mm.	40 mm.
Breadth at anterior edge	23, 24, 29, 30 mm.	20 mm.
<i>Vomer:</i>		
Length	18, 19, 19, 23 mm.	19 mm.
Breadth	16, 17, 18, 19 mm.	10 mm.
<i>Basisphenoid:</i>		
Width at Foramen rotundum...	58, 58, 58, 59 mm.	62 mm.
Width at apex of Petrous portions of Temporal	32, 33, 35, 35 mm.	30 mm.
<i>Pterygoid processes of Sphenoid:</i>		
Length	64, 65, 68, 69 mm.	51 mm.
Breadth, singly	17, 18, 18, 19 mm.	24 mm.
Breadth across	60, 60, 60, 62 mm.	79 mm.
<i>Articular condyle of Lower Jaw:</i>		
Width.....	32, 34, 36, 36 mm.	42 mm.
<i>Coronoid process:</i>		
Greatest width	26, 30, 30, 34 mm.	21 mm.
Width between Coronoid process and Articular condyle...	34, 34, 34, 41 mm.	21 mm.
Width from outside of Coronoid process to outside of Articular condyle	70, 73, 75, 79 mm.	56 mm.
<i>Nasals:</i>		
Length	38, 40, 41, 42 mm.	45 mm.
Width	28, 29, 33, 36 mm.	29 mm.
<i>Premaxilla:</i>		
Length	31, 31, 34, 36 mm.	39 mm.
Breadth across the canines.....	55, 70, 71, 73 mm.	90 mm.
<i>Zygoma:</i>		
Breadth at molar portion	30, 32, 32, 38 mm.	43 mm.
Breadth at narrowest part	16, 16, 17, 17 mm.	16 mm.
Length of skull front of <i>Arcus superciliaris</i> to front of Pre-maxilla		
	145, 146, 150, 153 mm.	160 mm.

doubtful characters, from lack of material, for *Gorilla castaneiceps* of Slack. The latter author gives as one of the principal characters (if not the principal) of his species, the red crown; now I have seen a good many Gaboon and Ogowe Gorillas, and I have found the red colour so variable that I am forced to regard *Gorilla castaneiceps* merely as a casual aberration of *Gorilla gorilla*. The cranial characters, as given by Matschie, appear to me also very uncertain. On the other hand, the *Gorilla manyema* of Alix and Bouvier I believe to be a very large ape of the group of *Simia vellerosus* Gray, and not a Gorilla at all, although Professor Matschie places it as a synonym of *Gorilla castaneiceps*. While I consider *G. castaneiceps* to be an aberration only of *G. gorilla*, I think Professor Matschie was rather bold to unite all South Camaroons Gorillas with the typical Gaboon *G. gorilla*. The Camaroons specimens I have seen appear to me to have shorter and stouter limb-bones, much longer hair, and the skulls show as a rule, though not always, a higher *crista sagittalis*. The facial portion is also shorter than in *G. gorilla*. These characters are more or less given by Matschie as probable points of distinction between *G. castaneiceps* and *G. gorilla*, but Slack did not found his species on these characters. Professor Matschie has separated the North Camaroons form of Gorilla as *G. diehli* on the evidence of eight skulls, all of which have the *planum nuchale* much wider than high. I am inclined to think that the N. and S. Camaroons Gorillas are merely geographical races of the Gaboon and Ogowe *Gorilla gorilla*, while, owing to the presence of full beard and the skull having certain very peculiar differences, the Gorilla from Kirunga, in German East Africa, ought to be upheld as a species, at least till we can examine fuller material. I propose to call the S. Camaroons race *Gorilla gorilla matschiei*, subsp. nov. Hair longer than in *Gorilla gorilla*, whole back and fore part of legs much greyer, limbs much shorter and stouter; crest of skull generally higher and rising closer to the *arcus superciliaris*; skull generally shorter: female much greyer.

From the foregoing particulars it will be seen that *Gorilla gorilla* and *G. gorilla matschiei* differ widely in the proportions of their skulls. (I have compared five fully adult males of equal size, all much above the average size.) The most striking differences are certainly in the shape of the *hinder surface of head* and the basioccipital bone, as well as the very widely different portion of the lower jaw comprising the coronoid process and the articular condyle. I have compared numerous other Gorillas' skulls—in all 27 ♂ and ♀, adult and young—in my possession, both from the Gaboon and the Camaroons, but they are all more or less imperfect or less adult than the five compared, so that the measurements could only have been partially given, therefore I did not think it advisable to quote them in this paper.

The casts of the type skulls ♂ ♀ of *Gorilla diehli* Matschie agree perfectly with two skulls wanting the lower jaws which I

possess, and which were brought back by Mr. G. L. Bates from the Camaroons, they being native killed, while the cast of *G. beringeri* Matschie shows differences from all skulls known to me.

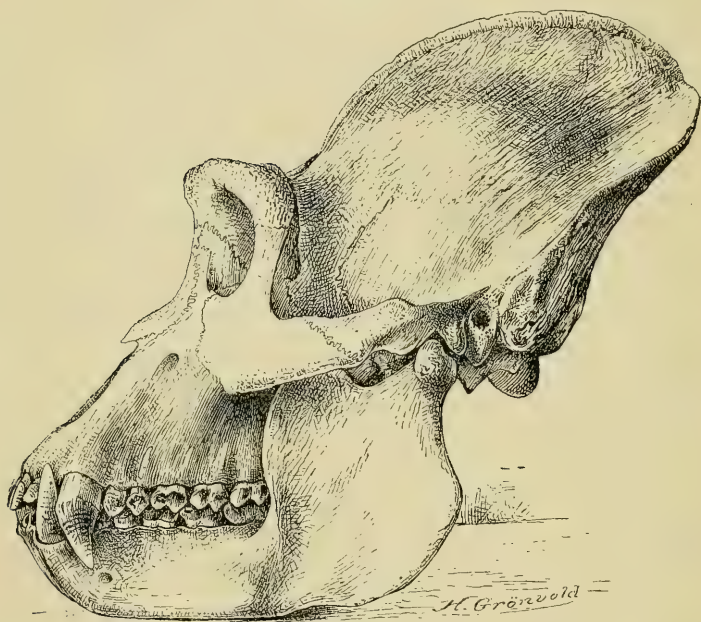
According to this classification, the species and subspecies of *Gorilla* would stand as follows:—

GORILLA GORILLA (Savage & Wyman). (Text-figs. 99 & 100.)

Boston Journal of Natural History, vol. v. p. 419 (1847).

Synonyms: *Gorilla gorilla* Is. Geoffr., 1852. *Troglodytes savagei* Owen, 1848. *Pithecius gesilla* Blainv., 1859. *Satyrops adrotes* Mayr, 1856. *Chimpanza gorilla* Haime.

Text-fig. 99.



Skull of *Gorilla gorilla* (Savage & Wyman). (Side view.)

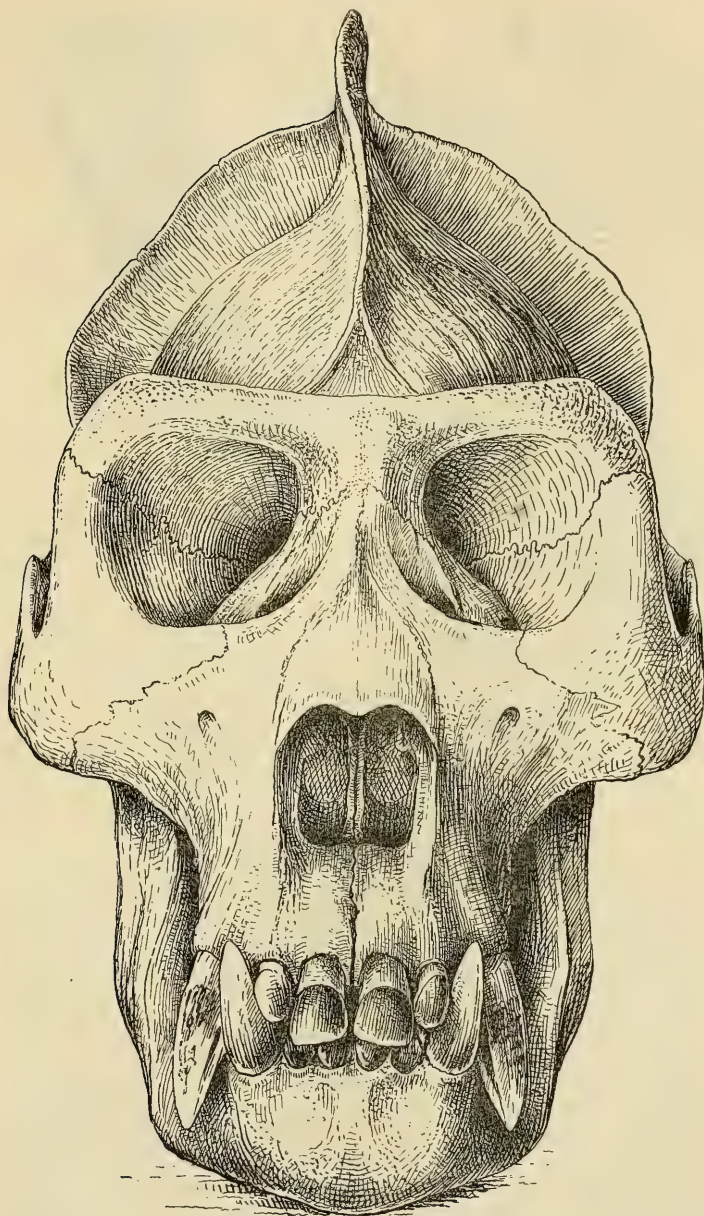
Aberration: *castaneiceps* Slack Proc. Acad. Nat. Sci. Philadelphia, pp. 159–160 (1862).

Habitat. Gaboon and Ogowe Region.

GORILLA GORILLA MATSCHIEI Rothsch. *antea*, p. 415. (Text-figs. 101 & 102, pp. 418, 419.)

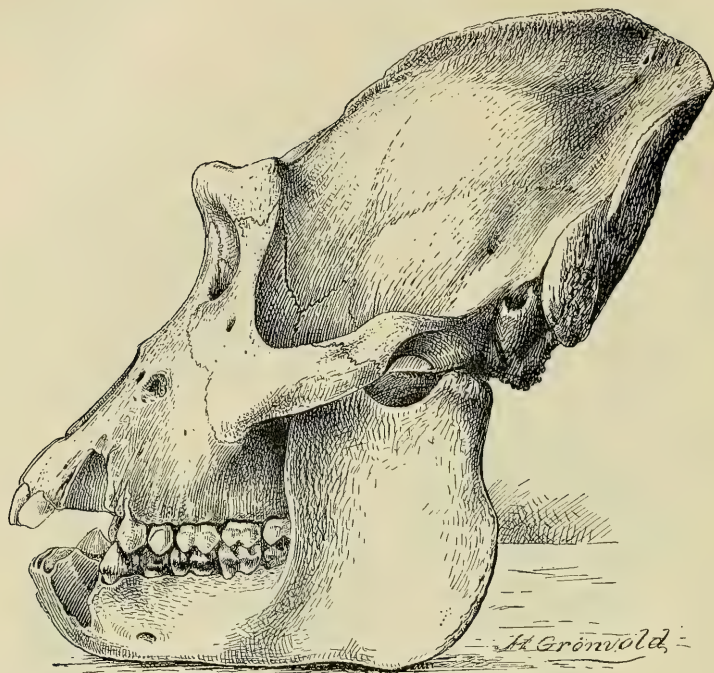
Habitat. Southern Camaroons.

Text-fig. 100.



Skull of *Gorilla gorilla* (Savage & Wyman). (Front view.)
PROC. ZOOLOG. SOC.—1904, VOL. II, NO. XXVII. 27

Text-fig. 101.

Skull of *Gorilla gorilla matschiei* Rothsch. (Side view.)

GORILLA GORILLA DIEHLI Matschie. (Text-fig. 103, p. 420.)

Sitzungsber. Ges. naturf. Freunde Berlin, 1904, p. 52.

Habitat. Northern Camaroons.

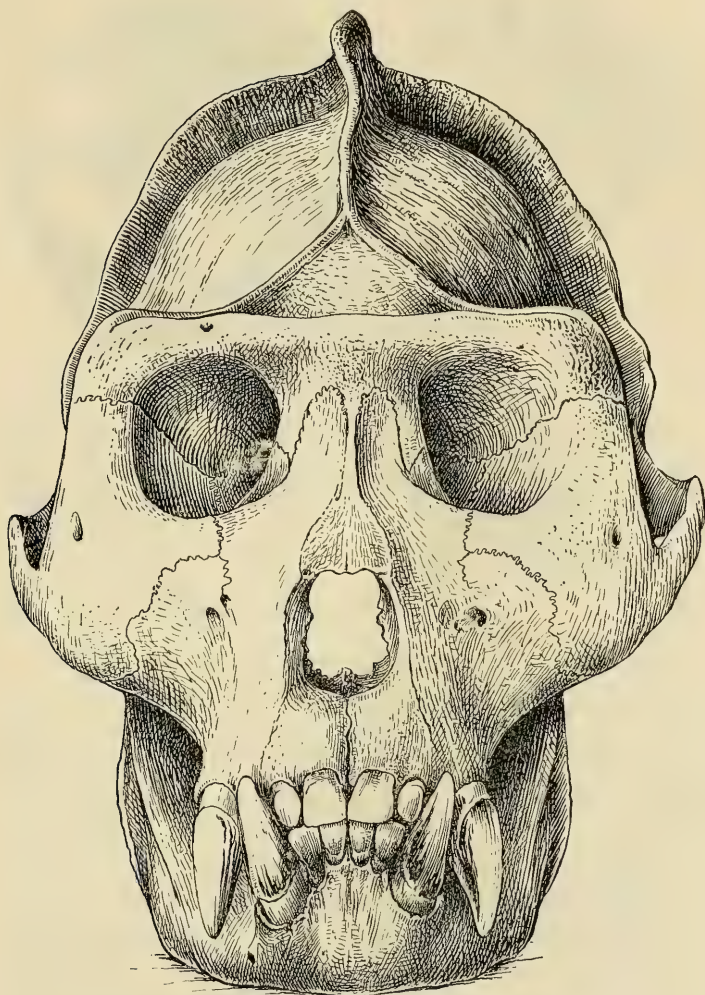
GORILLA BERINGERI Matschie. (Text-fig. 104, p. 421.)

Sitzungsber. Ges. naturf. Freunde Berlin, 1903, pp. 253–259.

Habitat. Kirunga, Ya Sabinyo Volcano, German East Africa.

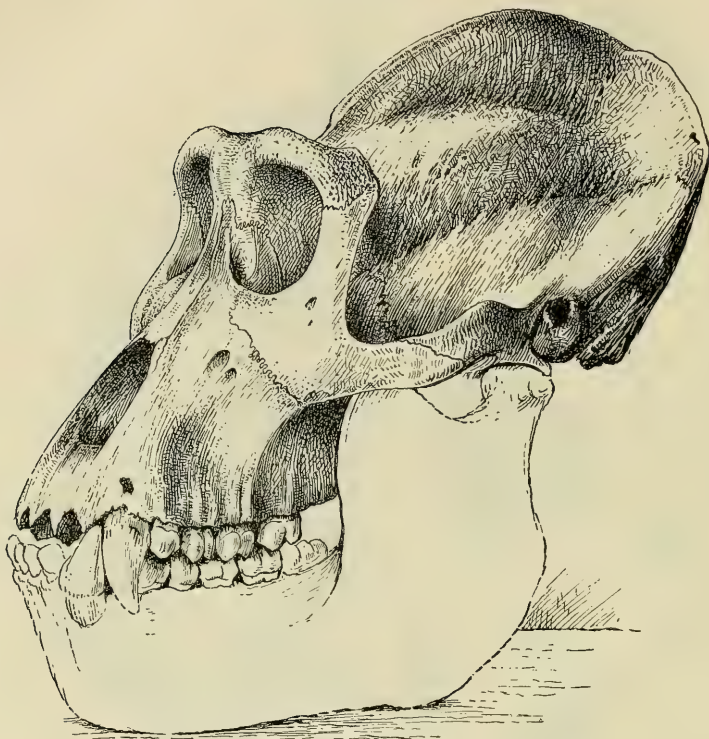
The genus and species of Chimpanzees now must be considered, and the first and most vexed question is that of the correct nomenclature. In common with Mr. Oldfield Thomas and most of the continental and American zoologists, I adopt, as the starting-point, Linnaeus's tenth edition of the 'Systema Naturæ' (1758). This being the case, I must now go into the changes it necessitates. In the first place, *Anthropopithecus* Blainville, 1838, must sink, as we find by the help of Palmer & Merriam's 'Index Generum Mammalium,' p. 109, that there are the following generic names older than *Anthropopithecus*, viz.:—*Troglodytes* Geoffroy, 1812; *Pan* Oken, 1816; and *Theranthropus* Brookes, 1828. *Troglodytes* was used as a name for the Wren in 1806 by Vieillot, while

Text-fig. 102.

Skull of *Gorilla gorilla matschiei* Rothsch. (Front view.)

Mimetes of Leach, 1820, another name for the Chimpanzee, was also preoccupied. I, therefore, who, in opposition to Professor Matschie, consider Oken's names applicable, would have had to accept *Pan* as the generic name of the Chimpanzee, as do many American writers, but for the fact that a still older name exists. Linnæus describes as the first species of his genus *Simia* in the
27*

Text-fig. 103.



Skull of *Gorilla gorilla diehli* Matschie. (In Tring Museum.)

‘*Systema Naturæ*,’ i. p. 25 (ed. x. 1758) an anthropoid ape as follows:—

“*Satyros*. 1. *S. ecaudata* subtus nuda. *Syst. Nat.* vi. p. 3.

Satyros indicus Tulp. obs. III c. 56.

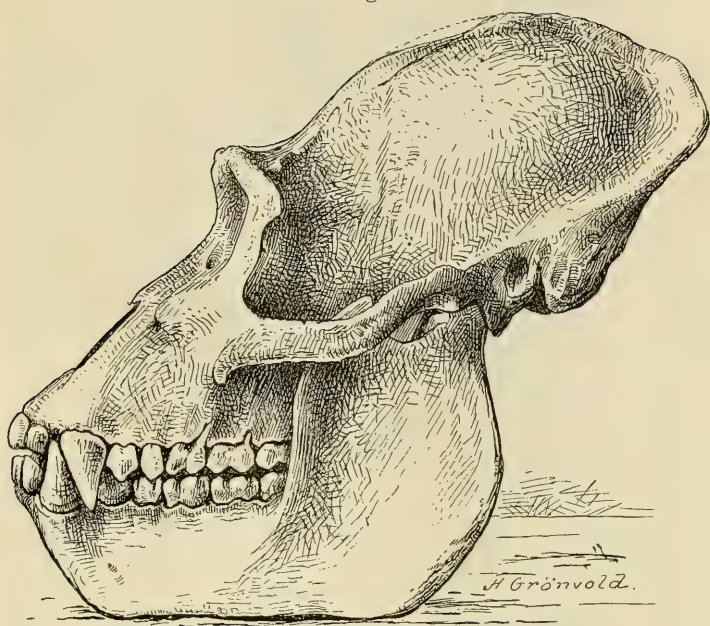
Habitat in Africa. Asia.

Magnitudine pueri sexennis. Dorsum crinibus nigris hirsutum; subtus s. antice undique glaber.”

Tulp described and figured an ape which was brought from West Africa and presented to Prince Frederick Henry of Orange, and which lived some years in Europe.

Linnaeus copied Tulp’s description almost word for word, and, as quoted above, expressly states that the *S. satyros* was black on the back. It was only in his twelfth edition (1766) that Linnaeus calls the Orang-Outan *Simia satyros*, and says it is red-haired, but he had already, in the ‘*Amœnitates Academicæ*,’ vi. p. 69 (1763), named the red-haired animal *Simia pygmaeus*. Not only,

Text-fig. 104.

Skull of *Gorilla beringeri* Matschie.

however, can we prove that Linnaeus's *Simia satyrus* is really a Chimpanzee, but we can even distinguish the exact race to which the name applies, for Tulp's description and figure show an ape the hair of which is not parted in the centre of the head, and with a short thick beard clothing the cheeks and leaving the chin bare. These characteristics are found in the Chimpanzees from the coast-lands of the South Camaroons and the Gaboon and Ogowe districts. It is therefore necessary to adopt the name of *Simia* L. for the genus of the Chimpanzees, and the famous "Tschego" proves to be the veritable *Simia satyrus*. According to Palmer, on the other hand, we have the following generic terms for the Orang-Outan or Maias:—

Satyrus Lesson, 1799; *Pongo* Lacepède, 1799; *Pithecus* G. Cuvier, 1800; *Lophotus* G. Fischer, 1813; *Faunus* Oken, 1816; *Macrobates* Billberg, 1828; and *Brachiopithecus* Sénéchal, 1839. As *Satyrus* of Lesson and *Pongo* of Lacepède are of equal date, I think we must adopt, as the least confusing name, *Pongo* of Lacepède, and therefore the correct name of the Orang-Outans as a group is *Pongo pygmaeus* (Linn.).

Professor Matschie, in his article on the Chimpanzees, Sitz. Ges.

naturf. Fr. 1904, pp. 55–69, acknowledges seven species of the genus *Simia*. According to the view of the value of various animal forms which I take up, as a large proportion of these represent one another geographically, they ought to be treated only as subspecies. This diversity of opinion between Professor Matschie and myself is more apparent than real, for in many cases Professor Matschie regards what I call “species” as genera or subgenera, while he considers what I call “subspecies” to be species, thus only differing in the terms to apply to certain categories of individuals. According to our present state of knowledge of the Chimpanzees, there are two very well-defined groups, namely, the *Simia satyrus* group, with black or blackish-brown faces when adult, and the *Simia pygmæus* group, with pale faces both in the adult and young stages. From this it will be seen that I differ entirely in one point of nomenclature from Professor Matschie—namely, I hold that a specific name can be used for a species, even if previously used in a different sense, so long as the species first denoted by the name has since been placed in another genus. I therefore consider *Simia pygmæus* applicable to one of the races of Chimpanzee, because Linnæus’s *Simia pygmæus* must now stand as *Pongo pygmæus*. In addition to the seven forms of *Simia* recognised by Matschie in his paper (Sitzungsber. Ges. nat. Fr. Berl. 1904, pp. 54–69), there are several more, among which is a pale-faced Chimpanzee which comes from some part of the French Congo, which I propose to name *Simia pygmæus varipilosus*, subsp. nov., distinguished from other forms of *Simia pygmæus* by the sparse, almost absent, beard, narrow protruding face, and very long limbs, largish ears, rounded forehead, and only partially divided hair on the head.

Professor Matschie’s paper gives the forms as follows:—

1. *SIMIA SATYRUS* L. Syst. Nat. i. p. 25 (1758). (Text-figs. 105, 106, 107, & 109, fig. 1, pp. 423, 424, 426.)

Synonyms: *Simia troglodytes* Gm., 1788; *Troglodytes niger* Geoffr., 1812; *Troglodytes koolo-kamba* Du Chaillu, 1861; *Troglodytes aubryi* Gratiolet & Alix, 1866; *Pseudanthropus fuliginosus* Schaafuss, 1875.

Distribution. Lower Guinea from Sanaga in the Camaroons to the Ogowé.

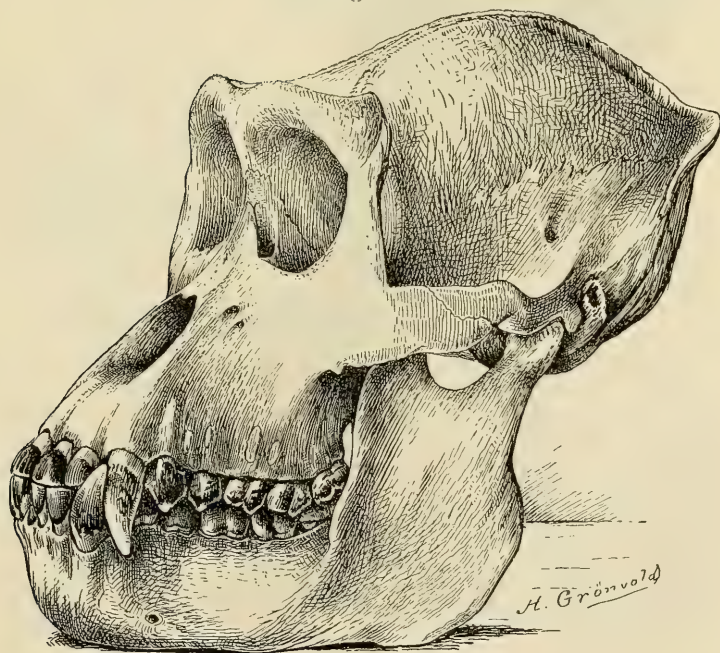
Distinctive characters. *External:* hair of head not parted in centre; hair on forehead falls out in adults, but not so far as level of ears. Ears medium size, 65 × 50 millimetres. A narrow beard of thick short hairs pointed downwards surrounds the face except chin, which is sparsely covered with dark grey hairs. Arms very long, exceeding 700 mm. Colour of face in the young leather-yellow, in adult animals blackish brown.

Cranial characters: facial portion of skull very narrow, much constricted behind the canine teeth; the greatest breadth of the skull is never more than 1 mm. greater at the canines than at the molars. The brain-case is an elongate egg-shape, measuring from the glabella to the protuberantia occipitalis in the ♂ ♂

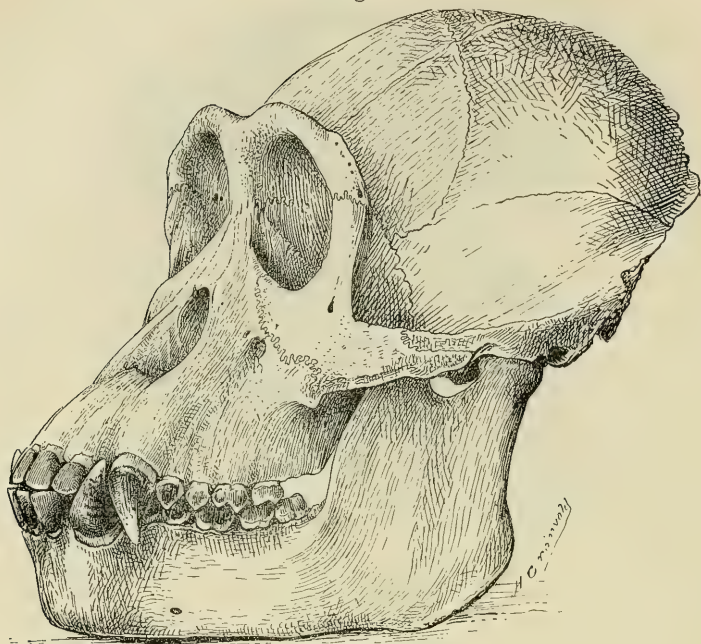
Text-fig. 105.

Head of *Simia satyrus* Linn. (From life.)

Text-fig. 106.

Skull of *Simia satyrus* Linn. (Fully adult.)

Text-fig. 107.

Skull of *Simia satyrus* Linn. (Fere adult.)

134–142 mm. and in the ♀ ♀ 122–130 mm. The thinnest place in the *zygomatic arch* is 5–9 mm. high (always over 7 mm. in old ♂ ♂).

2. *SIMIA CALVUS* (Du Chaillu), Proc. Boston Soc. Nat. Hist. vii. p. 296 (1861).

Distribution. Interior of Gaboon Region and Southern Camaroons.

Distinctive characters. *External:* hair of head not parted in centre, falls out when adult to behind base of ears; the ears are enormous, 80 × 53 mm. at least. *Beard* laterally thin and longer than in *S. satyrus*, and does not join under the chin. *Chin* sparsely covered with white hairs. *Length of arms* in adult animals 600 mm. *Colour of face* in adult animals brownish black; *eyes* light brown, in young animals wood-brown, *ears* yellowish.

Cranial characters: *facial portion of skull* apparently very wide, as it is expanded behind the *canines*. The greatest width at the canines is 5 mm. narrower than at the *molars*. The brain-case is round, the greatest length from the *glabella* to the *protuberantia occipitalis externa* is the same in ♂ ♂ and ♀ ♀, viz. 127–139 mm.

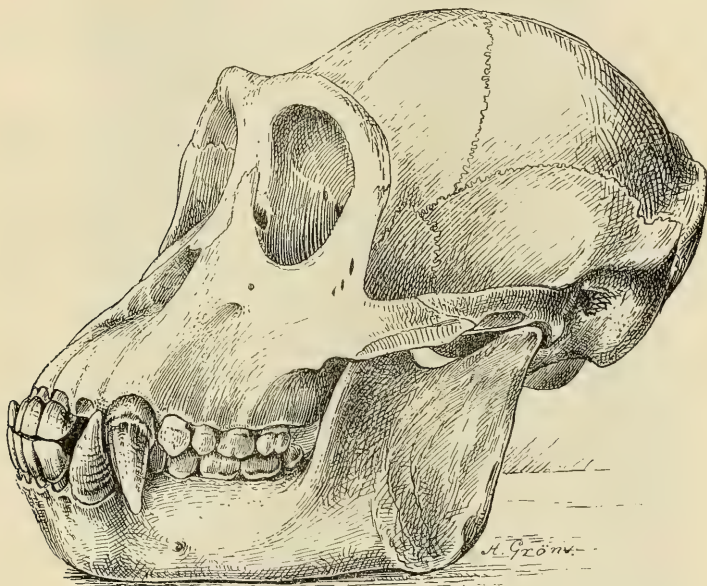
and over the arch of the forehead 141–160 mm. The breadth at the *canines* is 50–60 mm. in the ♂♂ and 54–68 mm. in the ♀♀. The thinnest place in the *zygomatic arch* is 7–10 mm. (always at least 9 mm. in old ♂♂).

3. *SIMIA VELLEROSUS* (Gray), P. Z. S. p. 181 (1862). (Plate XXIV. and Text-figs. 108 & 109, fig. 2.)

Distribution. Northern Camaroons and higher mountains further south.

Distinctive characters. *External:* ears very small, 50×45 mm. *Beard* very long and thick, completely surrounding face. *Arms* very long, at least 750 mm. in length; *face* brown (*W. R.*). (Colour of hair in fully adult old ♂♂ is yellowish grey.—*W. R.*)

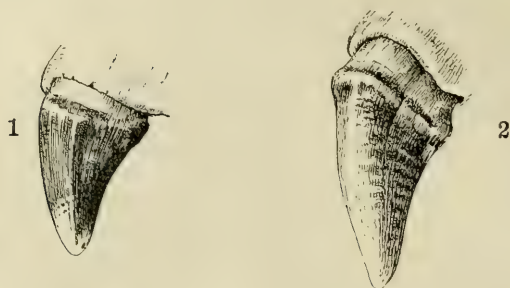
Text-fig. 108.



Skull of *Simia vellerosus* (Gray).

Cranial characters: *facial portion of skull* slender, flat in front of nostrils; breadth behind *canines* from 1 mm. less to 1 mm. more than between the molars. *Brain-case*, measured from the *glabella* to the *protuberantia occipitalis externa* much shorter in the ♂♂ than in the ♀♀, viz. 131–132 mm. and 137 mm. respectively; measured over the arch of the forehead 150–152 mm. and 160 mm. respectively. Breadth at *canines* in ♂♂ 62–63 mm., in ♀♀ 55 mm. The thinnest place in the *zygomatic arch* is 6–9 mm. high.

Text-fig. 109.

Left canine tooth of :—1. *Simia satyrus* Linn." " 2. *Simia vellerosus* (Gray).

4. *SIMIA SCHWEINFURTHI* Giglioli, Ann. Mus. Civ. Genova, iii. p. 135 (1872). (Text-fig. 110, p. 427.)

Synonyms : *Troglodytes marungensis* Noack, 1887.

Distribution. Niam Niam to South-eastern Soudan, and from Lake Tanganyika to Uganda Protectorate (and perhaps to Lake Chad and Wadai.—*W. R.*).

Distinctive characters. *External* : face, when young, pale, when adult, according to Matschie, dark. *Ears* very large (no exact measurements known). *Beard* enormously long and thick. *Chin* thickly covered with long white hairs. *Arms* very long indeed. *Hair* generally very long and thick.

Cranial characters : *facial portion of skull* extremely narrow, at the very outside only 55 mm. broad, behind the *canines*, but not so wide even at the widest part of the *palate*. *Brain-case* almost round, of equal length in both sexes, measured from the *glabella* to the *protuberantia occipitalis externa* 128–133 mm., measured over the arch of the forehead 150–160 mm. Breadth between the *molars* 51–55 mm., between the *canines* 49–55 mm. The thinnest place in the *zygomatic arch* is 4–7 mm. high.

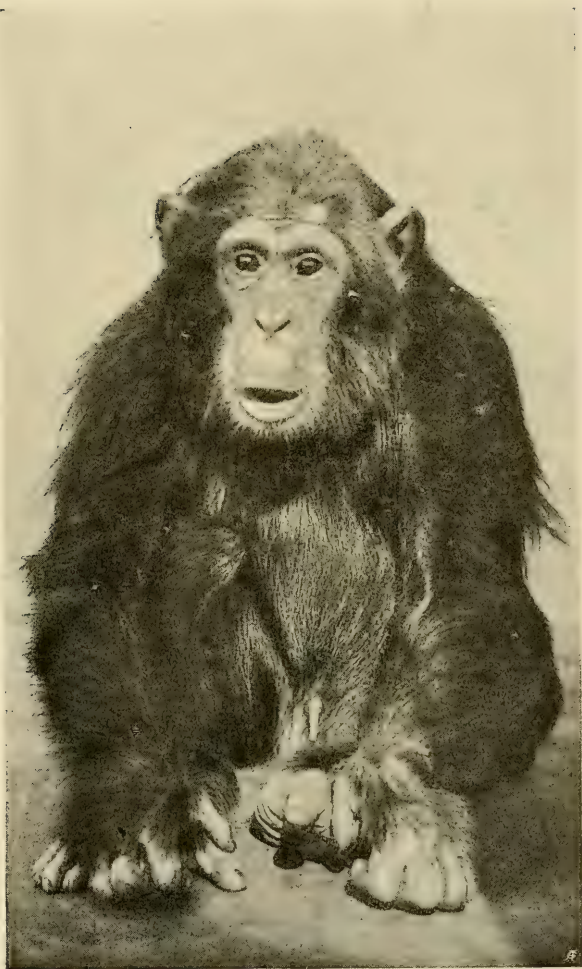
5. *SIMIA FUSCUS* (Mayer), Abh. und Ber. Mus. Dresd. No. 14, p. 7 (1894–1895).

Distribution. ? Probably between Liberia and Togoland.

Distinctive characters. *External* : *hair-whorl* on the top of the head, from which hair falls on all sides. *Ear* blunt, almost flat at the top. *Region of eye* darker than *nasal region*. *Beard* long and entire.

Cranial characters : *facial portion of skull* slender. About the same width behind the *canines* as at the *molars*, viz. 53 mm. *Brain-case* in a ♀ skull measures in length from the *glabella* to the *protuberantia occipitalis externa* 128 mm., and over the arch of forehead 155 mm. *Zygomatic arch* at its thinnest place is still 8·5 mm. high.

Text-fig. 110.



Simia satyrus schweinfurthi (Gigl.). (From a photograph from life.)

6. *SIMIA LEUCOPRYMNUS* Lesson. 1831.

Synonyms: *Simia pygmaeus* Schreber, Säugthiere, Taf. 1 B (1796).

Distribution. Probably Sierra Leone and Western Liberia.

Distinctive characters. *External:* hair of head parted in the centre, very thin on the strongly-arched forehead. *Ears* very large and rounded at the top. *Region of the eyes* as pale as rest

of face. *Chin* sparsely clothed with brown hairs. *Beard* short and thick and surrounding chin.

Cranial characters: *brain-case* flat; *occipital region* flat and much lengthened; *facial portion of skull* slender, not expanded at the *molars*.

7. *SIMIA CHIMPANSE* (Mayer) Arch. Naturg. xxii. (i.) p. 282 (1856).

Distribution. Gambia and Senegambia.

Distinctive characters. *External*: *hair of head* parted in centre; *ears* large; *beard* laterally long, standing out from the face; *chin* free and clothed with white hairs.

To these forms I must add the following:—

SIMIA RARIPILUSUS Rothsch. *antea*, p. 422. (Text-fig. 111.)

Distribution. Probably some part of the interior of French Congo.

Text-fig. 111.



Head of *Simia pygmaeus raripilosus* Rothsch. (From life.)

Distinctive characters. *External*: *hair of head* not or partly

parted in centre; *hair* very sparse all over body; *arms* very long; *beard* almost absent.

Since writing the paper (Sitzungs. Ges. naturf. Fr. Berl. 1904, pp. 55-59) Professor Matschie has examined over one hundred Chimpanzees, including the types of *Trog. aubryi*, *Tr. niger*, *Tr. calvus*, *Tr. koolookamba*, *Tr. tschego*, *Tr. troglodytes*, *Tr. fuliginosus*, *Tr. marungensis*, and *Tr. leucoprymnus*, besides many skulls, and in consequence has found much in the above-quoted article which requires altering. With such of those alterations as he has communicated to me I quite agree. The conclusions both he and I have come to make it clear that there are at least four distinct species of Chimpanzee (*Simia*) all living side by side throughout the greater part of their range, while I, personally, maintain there are five such species. The five species, according to the geographical and physical position of various portions of their range, again fall into a number of well-developed subspecies = geographical races; and we find that at present we have twelve named races belonging to five species; while Professor Matschie, in a forthcoming paper, proposes to describe, besides others, two new forms from Liberia, two from Central Congo, and three from the Uelle region. At present I only propose to deal with the twelve named forms of which the following are the Key and Synopsis, which latter, I hope, will be understood by aid of the former; but the notes following them will no doubt clear up much.

KEY.

- | | | | |
|---|---|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------|
| 1 | { | Face of adult black or blackish brown..... | 2 |
| | | Face of adult pale | 3 |
| | { | Hair long, harsh and black; arcus superciliaris strongly developed..... | <i>Simia satyrus marungensis</i> . |
| | | Hair long and soft, generally yellowish grey in very old animals. Last lower molar very small; facial portion of skull very short; canines very large. | <i>Simia vellerosus</i> . |
| | | Hair long and soft, sooty-brown to black. | <i>Simia vellerosus fuliginosus</i> . |
| 2 | { | Hair and beard very long, limbs long; head narrow and very high, face olive-brown. | <i>Simia satyrus schweinfurthii</i> . |
| | | Hair black, short, and harsh; head round, ears enormous. | <i>Simia koolookamba</i> . |
| | | Hair short, harsh; head long; arcus superciliaris strongly developed. Last lower molar showing four very ill-defined tubercles, facial portion of skull long, canines small | <i>Simia satyrus</i> . |
| | | Hair black and short, ears very small; face very prognathous; last lower molar with five large tubercles as in <i>Gorilla</i> ; eyes very wide apart ... | <i>Simia aubryi</i> . |

- 3 { Region round eyes dark..... *Simia pygmæus chimpanse*.
 Region round eyes pale, like rest of face 4
- { Beard short, sparse, almost absent; hair short, thin,
 and black; face pale, blotched with dark tan.
Simia pygmæus raripilosus.
- 4 { Face pale flesh-colour, beard thick and long; hair
 long, thin, and black; head round, ears set on low.
Simia pygmæus.
 Hair, even when young, mostly reddish; hair on chin
 whitish; hair of head spreading from central whorl,
 beard entire and long *Simia pygmæus fuscus*
 Hair on head sparse, ears large, chin-hairs brownish.
Simia pygmæus leucopymnus.

This Key is as close as I have been able to work, but when some of the remaining subspecies are described it must be revised.

SYNOPSIS.

1. *Simia vellerosus* (Gray). Camaroons.
- 1a. *Simia vellerosus fuliginosus* (Schaufuss). Congo region.
2. *Simia satyrus* (Linn.). Camaroons and Gaboon.
- 2a. *Simia satyrus marungensis* (Noack). Central Congo. (Text-fig. 112, p. 431.)
- 2b. *Simia satyrus schweinfurthi* (Giglioli). Soudan and Uganda.
3. *Simia koolookamba* (Du Chaillu). Camaroons and Gaboon.
4. *Simia aubryi* (Gratiolet & Alix). Camaroons and Gaboon.
5. *Simia pygmæus* Schreber. Congo. (Text-fig. 113, p. 432.)
- 5a. *Simia pygmæus fuscus* (Mayer). Gold Coast?
- 5b. *Simia pygmæus leucopymnus* (Lesson). Sierra Leone and S. Liberia.
- 5c. *Simia pygmæus chimpanse* Matschie. Gambia. (Text-fig. 114, p. 433.)
- 5d. *Simia pygmæus raripilosus* Rothschild. French Congo.

In Professor Matschie's previously cited paper, first of all, under the head of *Simia satyrus* Linn. he has confused four species, viz. *S. satyrus*, *S. koolookamba*, *S. aubryi*, and *S. vellerosus*, in fact all the black-faced species. As now ascertained, Linnæus's species must stand as *SIMIA SATYRUS* Linn. Syst. Nat. i. 25 (1758).

Synonyms: *Simia troglodytes* Gm., 1788; *Troglodytes niger* Geoffr., 1812; *Troglodytes tschego* Duvernoy, 1855; and *Troglodytes calvus* Du Chaillu, 1861.

Troglodytes aubryi Gratiolet & Alix, 1866, must stand as a good species as *SIMIA AUBRYI* (Grat. & Alix).

Troglodytes koolookamba Du Chaillu must stand as a distinct species as *SIMIA KOOLOOKAMBA* (Du Chaillu). (Text-fig. 115, p. 434.)

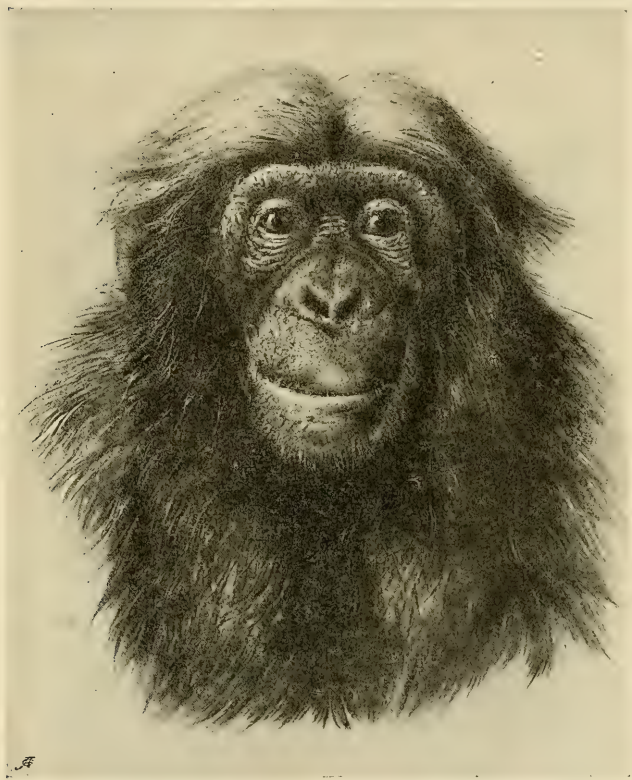
Simia calvus Matschie (*nec* Du Chaillu) is the same as *Simia vellerosus* (Gray).

Simia vellerosus Matschie (*nec* Gray) is a mixture of *S. vellerosus* and *S. aubryi*.

Pseudanthropus fuliginosus Schaufuss is the Loanga subspecies of Gray's *Troglodytes vellerosus*, and will have to stand as *SIMIA VELLEROSUS FULIGINOSUS* (Schauf.).

Simia pygmaeus Schreber is not a synonym of *T. leucoprymnus* Lesson, as Professor Matschie has placed it, but is a distinct subspecies.

Text-fig. 112.



Head of *Simia satyrus marungensis* (Noack). (From life.)

In the preceding pages I have endeavoured to compress into concise limits all that could be ascertained of the natural divisions and classification of the African anthropoid apes in the light of modern study and investigations. We now come to the Asiatic anthropoids; and if the Gorillas and Chimpanzees offer serious difficulties to the student, the Asiatic Orangs present difficulties ten times worse. I do not for a moment wish to assert that my conclusions are even as closely correct as in the Gorillas and

Chimpanzees, but seeing that we are faced by two distinct problems, when trying to classify the large red apes of Borneo and Sumatra, I think the present arrangement clears up a few difficulties and is an advance on former classifications. The first of the above problems connected with the Orangs is, that throughout their entire range two forms are found living side by side which are extremely different in appearance. In one of these the adult males are very large and have huge callosities on each side of the face, in the other the adult males are smaller and have no sign of any face- (*i. e.* cheek-) callosities. There is considerable diversity

Text-fig. 113.



Head of *Simia pygmaeus* Schreber. (From life.)

of opinion as to what is the correct position to assign to these two forms. Professor Matschie not only considers them to be distinct species, but even goes so far as to say they are distinct genera. I cannot at all agree to even considering them distinct species, but feel sure they are only dimorphic phases of one species.

The second problem presented by the Orang-Outans is whether there are a number of different species or whether there is only one variable species consisting of a number of geographical races or subspecies.

Professor Matschie inclines to the former view, while Dr. Selenka

takes the latter. I am convinced that this is the right view to take, and that many who side with Professor Matschie go too far in splitting up the forms of Orang. Dr. Selenka gives a very plausible and, I believe, well justified explanation for the existence of a number of local races in Borneo, viz., that the Orang-Outans cannot swim and can only climb mountains, when bare of trees, with difficulty; and as Borneo is intersected in all directions by broad rivers and high mountain-ranges, the Orangs in the various districts are almost as much isolated as if confined to separate islands.

Text-fig. 114.



Head of *Simia pygmaeus chimpanse* Matschie. (From life.)

Dr. Selenka separates 8 races of Orangs from Borneo and Sumatra, 4 with cheek-callosities and 4 without, so that, as I consider these two forms dimorphic phases, he distinguishes actually 4 distinct subspecies. Professor Matschie distinguishes 14 races, or, as he calls them, species, from Borneo and Sumatra,

or according to my view 7 distinct subspecies, each being dimorphic. His 3 additional subspecies are Bornean, and will be described in his forthcoming paper. As I cannot find in previous writings on the Orangs any descriptions which can be employed to denote other forms than the 4 dimorphic subspecies recognised by Dr. Selenka, I shall only deal with them, and leave Professor Matschie to work out any forms, in addition to these 4, which may exist in collections.

Text-fig. 115.



Head of *Simia koolookamba* (Du Chaillu). (Very young animal.)
(From life.)

Dr. Selenka, in the Sitzungsber. Akad. Wissensch. Berlin, xvi. pp. 381-392, gives distinctive characters of his 8 races as follows:—

BORNEO.

A. ♂ ♂ with Cheek-callosities.

1. *Pithecus satyrus landakkensis*.—Hair deep reddish brown, rarely brownish yellow. Skull mikrencephalic and micrognathous; cubic capacity, ♂ ♂ 420-450 cb. cm., ♀ ♀ 350-390 cb. cm. 4th molar rarely present.

2. *Pithecus satyrus batangtuensis*.—Hair deep brown. Skull mikrencephalic and micrognathous; cubic capacity 400–437 cb. cm. in ♂♂, 350–420 cb. cm. in ♀♀.
3. *P. satyrus dadappensis*.—Hair dark reddish brown. Skull megalencephalic and macrognathous; cubic capacity in ♂♂ 470–534 cb. cm., in ♀♀ 360–490 cb. cm.

B. ♂♂ without Cheek-callosities.

4. *P. satyrus genepaiensis*.—Hair deep reddish brown. Skull megalencephalic and macrognathous; cubic capacity in ♂♂ 390–435 cb. cm., in ♀♀ 360–410 cb. cm.
5. *P. satyrus skalauensis*.—Hair dark brownish red. Skull megalencephalic and brachygnathous; cubic capacity in ♂♂ 440–500 cb. cm., in ♀♀ 330–440 cb. cm.
6. *P. satyrus tuakensis*.—Hair stiff and coarse, rusty yellow to rust-red; skin reddish; shape clumsy and expression coarse. Skull mikrencephalic and macrognathous. Malays call this form "Maia kesar," the "Coarse Orang," and this is the form almost always seen alive in Europe as it is hardier and travels better.

SUMATRA.

7. *Pithecus sumatranus deliensis*.—Hair brownish to foxy red. Face black. Old males with large cheek-callosities, mesencephalic; cubic capacity in ♂♂ 445–485 cb. cm., in ♀ 340 cb. cm.
8. *P. sumatranus abongensis*.—Hair deep brown. Old males without cheek-callosities.

Except that Dr. Selenka entirely overlooked the fact that of the 8 forms recognised by him 5 had already been named and described, and that therefore only 3 of his names can stand, he was most accurate in his distinctions, which is not to be wondered at as he has over 300 skulls, about 100 complete skeletons, about 100 skins, and many embryos and young for comparison, an amount of material obtainable nowhere else in the world. In addition to these 8 forms Dr. Selenka described, tentatively, a ninth form without cheek-callosities as *P. satyrus rantaiensis*, which will probably prove to be one of Prof. Matschie's 3 additional species. The following table will explain the relationship of the various subspecies of Orang-Outan, so far as the present state of our knowledge enables me to judge.

The table, however, requires considerable explanation, for although I have employed similar nomenclature in my entomological articles, it is something quite new when employed in connection with Vertebrata. As I have shown previously in this paper, the first name applied to the Orang-Outan after 1758, our nomenclatorial starting-point, was *Simia pygmaeus* of Linnæus,

1763, and therefore, as the first acceptable generic name is *Pongo*, we find that the name for the Orangs as a group is *Pongo pygmæus* (Linn.). Now this animal of Linnæus's is clearly shown by the description and Edwards's figure to have been a form *without* cheek-callosities, while we find in Schreber an ape, entitled *Simia agrias*, which equally clearly is a young specimen of a form *with* cheek-callosities. But of neither of these forms or phases have we any data which can satisfactorily determine to what subspecies they belong; therefore the names of these two phases can only, I think, with any propriety, be applied to the Landak-Sarawak form, and we arrive at the following combination:—

Pongo pygmæus, { form. dimorph. *pygmæus* (without callosities).
 { form. dimorph. *agrias* (with callosities).

But because this three-legged appellation applies only to one race of Orang-Outans, it is necessary to give names not only to each of the three other subspecies as a whole, but also to each dimorphic phase of each subspecies. Now Dr. Selenka called the phase with cheek-callosities from the Landak region *Pithecus satyrus landakkensis*, while he named the phase without cheek-callosities *P. satyrus tuakensis*; to these, however, I apply the names of *Simia pygmæus* of Linnæus and *S. agrias* of Schreber, so we get as the first Bornean subspecies of *Pongo pygmæus*:—

Pongo pygmæus { form. dimorph. *agrias* (with cheek-callosities).
 { (Text-fig. 116, p. 437.)
pygmæus, { form. dimorph. *pygmæus* (without cheek-callosities). (Text-fig. 117, p. 438.)

The phase with cheek-callosities from the Batangtu region was named *Pithecus satyrus batangtuensis* by Dr. Selenka, while he named the phase without cheek-callosities *P. satyrus skalauensis*; of these, one had, however, been described previously under the name of *Simia wurmbii* E. Geoff.; therefore the second Bornean subspecies must stand as follows:—

Pongo pygmæus { form. dimorph. *wurmbii* (with cheek-callosities).
 { form. dimorph. *skalauensis* (without cheek-callosities).

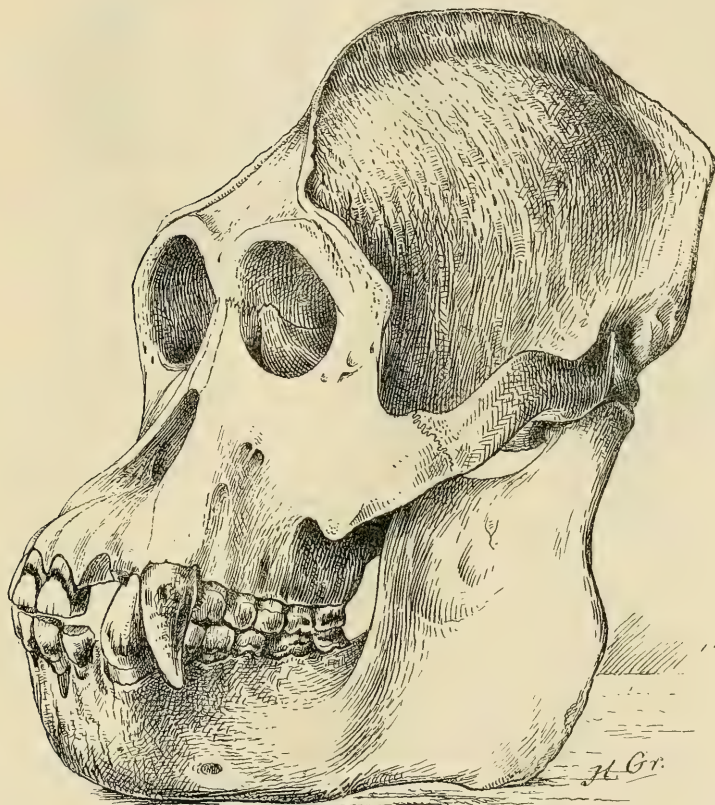
Dr. Selenka has called the phase with cheek-callosities from the Dadap-Genepai region *Pithecus satyrus dadappensis*, while he gave the name *P. satyrus genepaiensis* to the phase without cheek-callosities from the same region; therefore the third Bornean subspecies must stand thus:—

Pongo pygmæus { form. dimorph. *dadappensis* (with cheek-callosities).
 { form. dimorph. *genepaiensis* (without cheek-callosities).

The Sumatran Orang with cheek-callosities had the name of

Pithecus sumatranus deliensis bestowed upon it by Dr. Selenka, while he called the phase without the callosities *P. sumatranus obangensis*. Unfortunately, however, both these forms had had previous names given to them, viz. *Simia abelii* by Clarke and

Text-fig. 116.

Skull of *Pongo pygmaeus* forma *agrias* (Schreber).

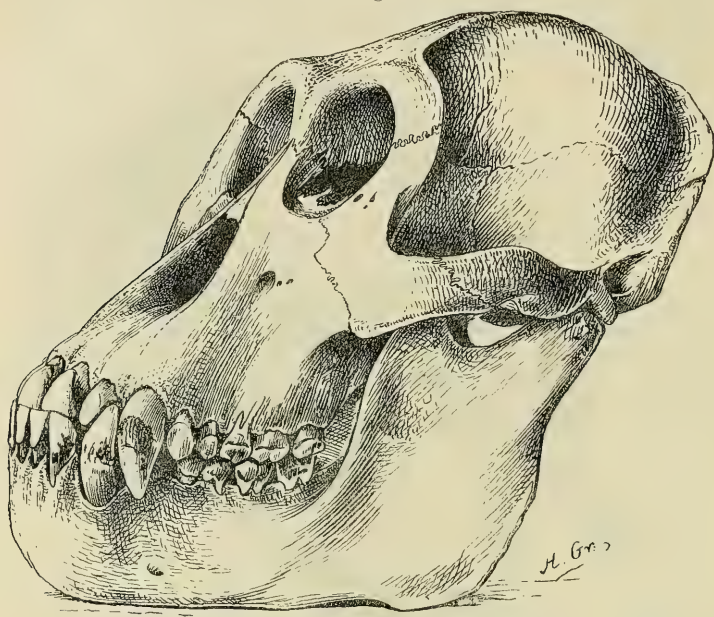
Simia bicolor by Isidore Geoffroy respectively; therefore the fourth and Sumatran subspecies of *Pongo pygmaeus* stands as follows:—

<i>Pongo pygmaeus</i>	{	form. dimorph. <i>abelii</i> (with cheek-callosities).
<i>bicolor</i> ,		form. dimorph. <i>bicolor</i> (without cheek-callosities).

After these explanations, I think the following synoptical table of the divisions and subdivisions of the Orang-Outan, *Pongo*

pygmæus (Linn.), will give succinctly the true nomenclature and relationship of the different forms.

Text-fig. 117.



Skull of *Pongo pygmæus* forma *pygmæus* (Linn.).

Entire Species.

PONGO PYGMÆUS (Linn.).

Bornean Subspecies.

1. Landak Subspecies.

<i>Pongo pygmæus</i>	{	form. dimorph. <i>agrius</i> (Schreber).
<i>pygmæus</i> ,		form. dimorph. <i>pygmæus</i> (Linn.).

2. Batangtu Subspecies.

<i>Pongo pygmæus</i>	{	form. dimorph. <i>wurmbii</i> (E. Geoff.).
<i>wurmbii</i> ,		form. dimorph. <i>skalauensis</i> (Selenka).

3. Dadap-Genepai Subspecies.

<i>Pongo pygmæus</i>	{	form. dimorph. <i>dadappensis</i> (Selenka).
<i>dadappensis</i> ,		form. dimorph. <i>genepaiensis</i> (Selenka).

Sumatran Subspecies.

Pongo pygmæus { form. dimorph. *abelii* (Clarke).
bicolor, { form. dimorph. *bicolor* (I. Geoff.).

I will now briefly summarise the results arrived at in this paper. I acknowledge, tentatively, 2 species of *Gorilla*, one with 3 subspecies; but eventually, with more material available, I think we shall find only one species, *Gorilla gorilla*, with 4 or more local subspecies. I have acknowledged 5 species of Chimpanzee, for which I employ the generic name *Simia*, as the oldest name given to a Chimpanzee was Linnaeus's *Simia satyrus* for the Tschego. I characterise 3 local races of *Simia satyrus*, 2 of *Simia vellerosus*, and 5 of *Simia pygmæus*, while as yet only one race each of *Simia aubryi* and *Simia koolookumba* are known to me. Of Orang-Outans *Pongo*, I can recognise only one very variable species, which can be divided up into a number of subspecies. I have characterised 4 such, each with a dimorphic phase, but our knowledge is so imperfect that I only wish to accept these 3 Bornean and 1 Sumatran races for the present, until a fresh lot of material arrives.

Professor Matschie, as a result of his last journey, is preparing a paper describing a much larger number of forms of Orang and Chimpanzee than I have dealt with in this paper, dividing them also into several genera; but, while fully awake to the possibility of a large number of additional forms existing, I have noticed here only such forms as are known to me at the time of writing.

In conclusion, I only wish to explain the standpoint I have taken up in writing this paper. My first contention relates purely to nomenclature. Hitherto, at least in Great Britain, zoologists have been divided as to the date to take as the starting-point for zoological nomenclature: ornithologists and entomologists taking Linnaeus's XII. edition of the 'Systema Naturæ' of 1766, while mammalogists take the X. edition of 1758. Also it has been customary for different zoologists to admit or disallow various changes in nomenclature. This variety of opinions has led to much confusion, and I therefore consider, as all writers on mammals of recent years and also the bulk of German and American zoologists, that the only way to obtain a uniform and final nomenclature is to adopt the tenth edition of Linnaeus, and adhere absolutely to the strictest law of priority in nomenclature, however intrinsically absurd or unsuitable a name may be.

I now come to my other contention. Much discussion has taken and is taking place as to the naming or not of local (*i.e.* geographical) races. The zoologists of the old school maintain that such races should not be named, and any variation of less than specific value should be ignored as regards the nomenclatorial point. The younger generation, however, declare that any distinction, however slight, ought to be signified by a name so long as it has geographical foundation. I am of the latter opinion. I am in favour of this method for many reasons; one of which is, that by

distinguishing all local races by a name we prevent the creation of useless synonyms by forcing the inexperienced student to study all of these before describing what appears to him a new species.

As to the method of denoting by names geographical races, there are many views, but I consider that much the most practical method is to add a third name to the two already possessed by the species. This method is no novelty, for it has been done since the time of Linnæus, the third name being coupled to the first two by the term "*varietas*." So long as "*varietas*" was only used to express a "geographical race" it answered very well, but soon it was also applied to individual variations and confusion reigned supreme. I consider, therefore, that it is important to abolish "*varietas*" from our nomenclature entirely, as it has so often been wrongly used, and to substitute the term "*subspecies*" for "*geographical races*" and the term "*abberatio*" for "*individual variations*." Thus the South Camaroons Gorilla would be called

Gorilla gorilla subspecies *matschiei*;

but this interpolation of the word subspecies makes the name very long and cumbersome, so that I and most Continental and American zoologists have agreed to leave out the term "*subspecies*" and to write the names of geographical races thus: *Gorilla gorilla matschiei*. It is seen, therefore, that this so-called innovation is no innovation at all, but simply the using of the long-established formula for local races in an abbreviated and more convenient form—*i. e.*, instead of writing *Gorilla gorilla varietas matschiei*, we simply leave out the word "*VARIETAS*" or its equivalent.

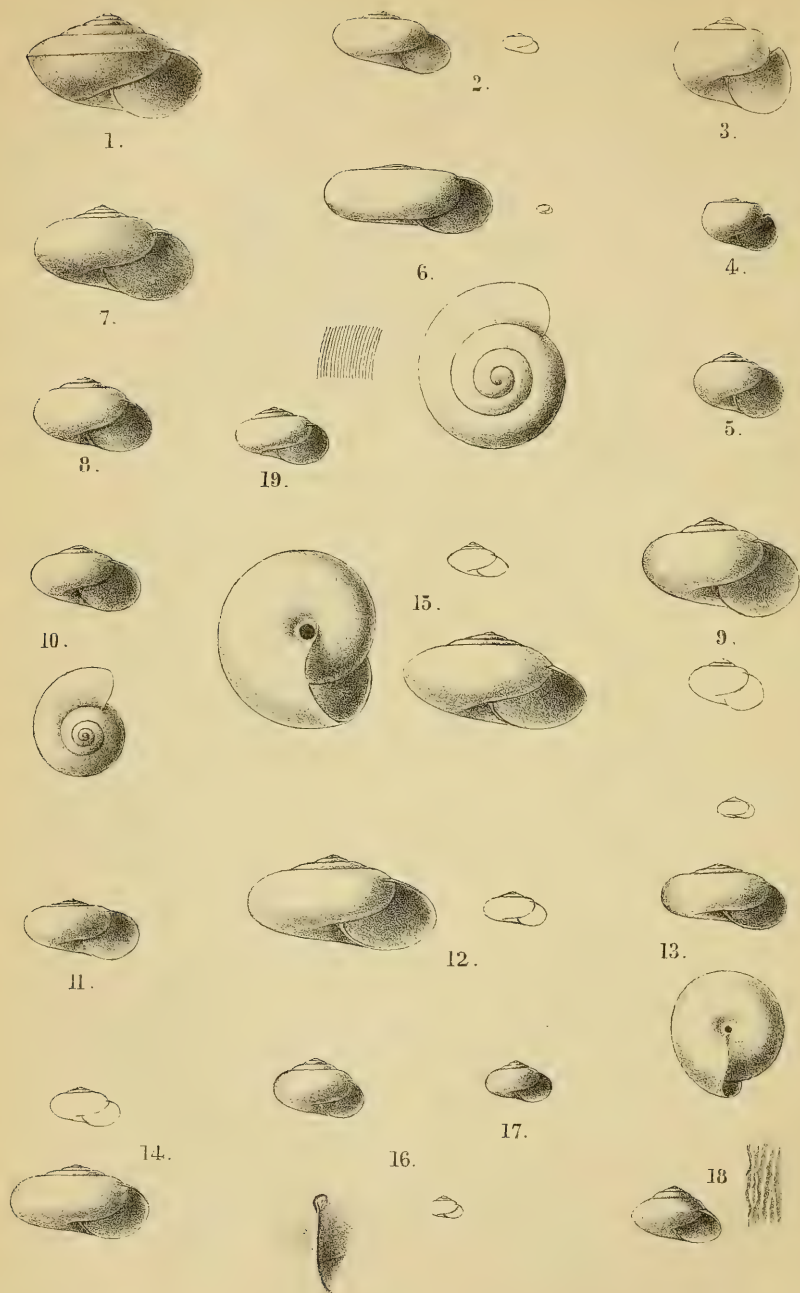
The chief reason, however, why I hold that geographical races ought to be named and diagnosed is that it facilitates so much the study of geographical distribution. Also the habits of local races are often widely different, and it prevents errors if differences in habits can be correlated to outward differences.

Some zoologists maintain that it is a mistake to describe "*subspecies*," as we cannot tell where individual variation ends and geographical variation begins.

This holds good only in the case of Reptiles, Fish, Mollusca, and most probably in the majority of the lower invertebrates; but in Insects, Birds, and Mammals it is practically always possible to tell whether a difference is racial or individual, and, I believe, even in the previously mentioned groups it will eventually be possible to define geographical races.

EXPLANATION OF PLATE XXIV.

Simia vellerosus (Gray) (very old male): p. 425.



4. Descriptions of Indian and Burmese Land-Shells referred to the Genera *Macrochlamys*, *Bensonia*, *Taphrospira*, (gen. nov.), *Microcystina*, *Euplecta*, and *Polita*. By W. T. BLANFORD, C.I.E., LL.D., F.R.S., V.P.Z.S.

[Received October 31, 1904.]

(Plate XXV.*)

The following pages contain diagnoses of several Indian land-shells that are believed to be undescribed. The majority belong to the genus *Macrochlamys*, and have been met with in the course of an attempt at monographing the forms found in the Empire of British India. Only those kinds have been described of which the localities are believed to be accurately ascertained, which are sufficiently distinct to render it probable that they may be recognised from their description, and of which type specimens are available for deposit in the British Museum.

Some of the specimens are from my own collections made in India and Burma, others are from the British Museum accumulations, whilst for others I am indebted to Colonel Godwin-Austen, Colonel Beddome, and Mr. Hugh Fulton. I have to acknowledge the valuable assistance and advice of Mr. E. A. Smith in my examination of the British Museum specimens.

BENSONIA NEPALENSIS, Nevill MS. (Plate XXV. fig. 1.)

Testa aperte perforata, conoideo-depressa, sublenticularis, tenuis, superne oblique et rugose plicata, subtus nitidior atque striatula, haud decussata; spira depresso-conoidea, sutura vix impressa; anfr. 6, convexi, regulariter accrescentes, ultimus non descendens, ad peripheriam carinatus, subtus tumidus; carinâ versus aperturam minus acutâ; apertura obliqua, rotundato-lunata, marginibus convergentibus; peristoma tenue, margine columellari curvato, denique verticali, undique expansulo, juxta perforationem late reflexo. Diam. maj. 23.5, min. 21, alt. 12 mm.

Hab. Khatmandu, Nepal.

Near *B. camura* Bs., but distinguished by a lower spire, smaller umbilicus, stronger sculpture, the absence of decussating striation and by less acute carination.

The types are in Col. Godwin-Austen's collection now in the British Museum.

TAPHROSPIRA †, gen. nov.

Testa depressa vel globoso-depressa, tenuis, cornea, ab illâ Macrochlamydis Bs., fossâ spirali extra suturam in omnibus anfractibus tantum diversa.

Typus *T. convallata*, Bs.

* For explanation of the Plate, see p. 447.

† τάφρος, a ditch or trench; σπειρα, spiral.

Animal not known.

So far as is known, the following species should be referred to this genus:—

- T. convallata* Bens. Tenasserim.
*T. bathycharax** Bens. MS. Andaman Islands.
T. compluvialis Blf. Arakan Hills, W. side.
T. excavata, sp. nov. Hills south of Assam.

TAPHROSPIRA EXCAVATA, sp. nov. (Plate XXV. fig. 3.)

Helix compluvialis, Hanley & Theob. Conch. Ind. pl. 88. figs. 1, 4 (1874), nec *Nanina compluvialis* Blf. (1865).

Testa perforata, globoso-depressa, tenuis, fusco-straminea, cornea, diaphana, nitida, minute transversim atque subobsolete sub lente longitudinaliter striata; spira parum exserta, apice obtuso, fossa suturali lata sed parum profunda; anfr. 5, superne extra fossam suturalem acute angulati, ultimus ad peripheriam rotundatus, subtus inflatus, versus aperturam vix descendens; apertura parum obliqua, rotundato-lunaris, superne emarginata, fere æque lata ac alta; peristoma tenue, vix sinuatum, margine columellari superne verticali, breviter triangulatim reflexo. Diam. maj. 15, min. 13, alt. 9 mm.

Hab. ad Asalu in provincia Cachar septentrionali (Godwin-Austen), necnon in montibus Khasi dictis teste Nevill.

This species resembles *T. compluvialis*, for which it has been mistaken, but which is a much less globose form and smaller, with a smaller, more oval and more oblique mouth, and closer and more distinct longitudinal striation under the microscope. *T. compluvialis* is figured for comparison, Pl. XXV. fig. 4.

MACROCHLAMYS KULUENSIS Nevill MS. (Plate XXV. fig. 5.)

Testa aperte perforata, subumbilicata, subgloboso-depressa, tenuis, translucens, nitida, pallide cornea; spira conoidea, sutura impressa; anfr. 5½, convexi, ultimus valde major, ad peripheriam rotundatus, subtus tumidus; apertura obliqua, rotundato-lunata, subæque lata ac alta; peristoma tenue, rectum, margine columellari verticali, triangulatim reflexo. Diam. maj. 12, min. 10.5, alt. 7 mm.

Hab. in pago Himalayano Kulu (coll. B.M.).

Near *M. glauca* and *M. nuda*, but distinguished by much more open perforation and rounder mouth.

MACROCHLAMYS SUPERFLUA, sp. nov. (Plate XXV. fig. 7.)

Testa perforata, depressa, tenuis, polita, translucens, vix striata, sub lente lineis impressis subconfertis spiralibus, decussatula, luteo- vel fusco-cornea; spira parum elevata, sutura bene impressa; anfr. 6, convexi, ultimus valde latior, ad peripheriam rotundatus, subtus convexus; apertura obliqua, subovate lunata, latior quam alta; peristoma tenue, margine basali

* Described by Mr. Hugh Fulton, Journ. Mal. x. p. 99 (1903).

recto, columellari superne verticali atque sublate reflexo, tunc oblique curvato. Diam. maj. 30, min. 17.5, alt. 10 mm.

Hab. in valle fluminis Tista, in provincia Sikhim interiore Himalayana satis frequens (*W. T. B.*).

This is a much larger shell than *M. sequax* with a different sculpture. The spaces between the longitudinal impressed lines appear papillose when considerably magnified.

MACROCHLAMYS (?) ATOMA Fairbank MS. (Plate XXV. fig. 6.)

Testa aperte perforata, depressa, discoidea, solidula, nitida, vitrea, lineis impressis parallelis subdistantibus spiralibus vel concentricis undique sub lente striata, albedo-cornea; spira fere plana, sutura impressa; anfr. 3½, regulariter accrescentes, superne convexi, ultimus non descendens, ad peripheriam rotundatus, subtus plano-convexus; apertura parum obliqua, lunata; peristoma tenue, marginibus supero basaliqve leviter arcuatis, columellari fere horizontali, haud reflexo. Diam. maj. 1.5, min. 1.2, alt. 0.6 mm.

Hab. prope ripas fluminis Godavari (*W. T. B.*).

This minute shell, found commonly amongst the debris left behind by river-floods, was named in MS. by the late Rev. S. B. Fairbank 40 years ago, and was mentioned in a report of mine written in 1866 and published in my absence in the Records of the Geological Survey of India, vol. i. 1870, p. 62. The typical specimens are from Paitan near Ahmednagar, and I have specimens from various places as far to the south-east as the first barrier on the Godavari at Dumagudem, also from the Wardha near Nagpur, and I believe I had some from the Nerbudda Valley.

This is probably not a *Macrochlamys* but the animal is unknown, only dead shells having been found. The only allied Indian form appears to be *M. anona* G.-A., from Calcutta, a much less depressed shell.

MACROCHLAMYS PRAVA, sp. nov. (Plate XXV. fig. 9.)

Testa perforata, subgloboso-depressa, tenuis, nitida, polita, quasi-obsolete sub lente spiraliter striata, rufescenti-fusca; spira vix elevata, conoidea, sutura parum impressa; anfr. 5, convexi, ultimus latior, ad peripheriam rotundatus, subtus tumidiusculus; apertura fere verticalis, subovato-lunata; peristoma tenue, rectum, margine columellari superne fere verticali ibidem reflexiusculo. Diam. maj. 10.5, min. 9, alt. 5.5 mm.

Hab. ad urbem Beypur prope litus Malabaricum (*Fairbank*): etiam ad latus occidentale montium Nilgiri (*W. T. B.*), et Anaimalai (*Beddome*), preterea in provincia Travancore (*Day*).

A common and rather widely spread form, resembling the Arakan species *M. kumahensis* Theob. & Stol. in form.

MACROCHLAMYS RUTILA, sp. nov. (Plate XXV. fig. 11.)

Testa perforata, depressa, tenuis, vitrea, polita, dense minuteqve regulariter sub lente et supra et subtus longitudinaliter

(*spiraliter*) *striata*, *castanea*; *spira humilis*, *sutura leviter impressa*; *anfr.* 6, *convexi*, *ultimus latior*, *ad peripheriam rotundatus*, *subtus convexus*; *apertura parum obliqua*, *lunata*; *peristoma tenue*, *marginē superiore vix arcuato*, *basali subrecto*, *columellari obliquo*, *breviter triangulatim reflexo*. *Diam. maj.* vix 15, *min.* 13, *alt.* 6 mm.

Hab. in dumeto 'Anagundi shola' dicto montium Anaimalai (Beddome).

MACROCHLAMYS CIAOS, sp. nov. (Plate XXV. fig. 8.)

Testa perforata, *conoideo-depressa*, *subglobosa*, *tenuis*, *nitida*, *vitrea*, *transversim striatula*, *sub lente lineis minutis crebris flexuosis spiralibus subobsolete sculpta*, *pallide fulva*; *spira parum elevata*, *apice acuto*, *sutura impressa*; *anfr.* $5\frac{1}{2}$, *convexiusculi*, *ultimus latior*, *ad peripheriam rotundatus*, *subtus convexus*; *apertura obliqua*, *rotundo-lunata*, *latior quam alta*; *peristoma pertenuē, rectum*, *marginē columellari curvato*, *superne verticali et breviter triangulatim reflexo*. *Diam. maj.* 16, *min.* 14, *alt.* 8 mm.

Hab. in Burma, ad Thayet Myo atque haud procul ab Ava (W. T. B.).

Very near the Bengal *M. subjecta* Bs., but distinguished by the presence of longitudinal sculpture. It is also more vitreous and less globose, with a narrower last whorl and smaller mouth.

MACROCHLAMYS NOTHA, sp. nov. (Plate XXV. fig. 19.)

Nanina petasus Blf. Jour. As. Soc. Beng. 1865, pt. 2, p. 86, nec Benson.

Testa perforata, *depressa*, *parum polita*, *vix striatula*, *lineis concentricis confertis ex tuberculis minutissimis constantibus sub lente undique ornata*, *flavescenti-fulva*; *spira breviter conoidea*, *apice subacuto*, *sutura impressa*; *anfr.* 6-7, *convexiusculi*, *lente accrescentes*, *ultimus ad peripheriam rotundatus*, *subtus convexus*; *apertura vix obliqua*, *fere verticalis*, *lunata*; *peristoma tenue*, *marginē basali arcuato*, *columellari expanso*, *oblique curvato*, *denique ad perforationem verticali*. *Diam. maj.* 11.5, *min.* 10.5, *alt.* 6 mm.

Hab. in montibus Aracanensibus inter Prome et Tongoop; necnon prope Thayet Myo, in provincia Pegu Burmannica.

Very close to *M. petasus* Bs., but distinguished by want of labiation and presence of longitudinal sculpture.

MACROCHLAMYS NOXIA, sp. nov. (Plate XXV. fig. 14.)

Testa minute et subobtectē perforata, *depressa*, *tenuis*, *nitida*, *polita*, *haud usquam striata*, *pallide castanea*, *subtus, nisi juxta peripheriam, albescens*; *spira vix elevata*, *conoidea*, *sutura impressa*; *anfr.* 6, *convexi*, *haud celeriter crescentes*, *ultimus ad peripheriam rotundatus*, *subtus convexus*; *apertura parum obliqua*, *late lunata*; *peristoma tenue*, *marginē basali arcuato*,

columellari obliquo, superne breviter reflexo. Diam. maj. 9, min. 8, alt. 4 mm.

Hab. ad latus occidentale fluminis Irawadi in pago Bassein provinciae Pegu Burmannicae (*W. T. B.*).

Varietas, anfractibus 5 munita, et spira aliquanto elevatiuscula prope portum Akyab in provincia Arakan invenitur.

This is near *M. hypoleuca* Blf. from Upper Pegu, best distinguished by being narrowly perforate and more depressed, and by the complete want of sculpture.

MACROCHLAMYS CURVILABRIS, sp. nov. (Plate XXV. fig. 13.)

Testa perforata, depressa, glabra, polita, vix striatula, fusca; spira parum elevata, sutura bene impressa; anfr. 5½, convexi, regulariter crescentes, ultimus versus aperturam aliquantulum descendens, ad peripheriam rotundatus, subtus plano-convexus; apertura obliqua, late lunata; peristoma obtusum, intus albolabiatum, sinuosum, margine supero vix arcuato, externo sinuato, basali valde arcuato, columellari obliquo, vix reflexiusculo. Diam. maj. 5.5, min. 5, alt. 2 mm.

Hab. in montibus Aracanensibus ad latus occidentale pagi Burmannici Prome (*W. T. B.*).

This is almost a miniature of the Tenasserim *M. aspides* Bs.

MACROCHLAMYS SPRETA, sp. nov. (Plate XXV. fig. 12.)

Testa minute et subobtectè perforata, depressa, tenuis, nitida, polita, lineis impressis spiralibus sub lente undique ornata, pallide castanea, subtus circa perforationem albescens; spira parum elevata, conoidalis, sutura vix impressa; anfr. 5, convexi, ultimus majusculus, ad peripheriam rotundatus, subtus convexus; apertura obliqua, subovato-lunaris; peristoma tenue, rectum, margine columellari obliquo, leviter reflexo. Diam. maj. 8, min. 7, alt. 3.5 mm.

Hab. ad Thamandewa in pago Bassein et in aliis partibus provinciae Pegu Burmannicae (*W. T. B.*).

Near *M. subpetasus* Nevill and *M. noxia*, but easily recognised by the spiral striation.

MACROCHLAMYS PATENS, sp. nov. (Plate XXV. fig. 15.)

Testa anguste sed perspective umbilicata, conoideo-depressa, sublenticularis, nitida, polita, lineis impressis spiralibus haud crebris spatiis inaequalibus discretis undique sub lente ornata, fulvo-fusca; spira conoidea, sutura parum impressa; anfr. 4½, convexiusculi, ultimus paullo latior, ad peripheriam obtuse angulatus, subtus convexus, circum umbilicum compressus; apertura diagonalis, fere trapezoidalis, subsecuriformis; peristoma tenue, rectum, margine columellari obliquo, triangulatum reflexo. Diam. maj. 7, min. 6, alt. 3.5 mm.

Hab. in Pegu; circa Thayet Myo, Bassein, &c. (*W. T. B.*).

MACROCHLAMYS PSEUDOCHOINIX, sp. nov. (Plate XXV. fig. 10.)

Testa subobtecte perforata, depressa, tenuis, glabra vix politula, subobsolete plicato-striata et lineis minutis confertis subflexuosis spiralibus undique decussatula, fusco-cornea; spira fere plana, sutura vix impressa; anfr. 5, planiusculi, ultimus valde latior, ad peripheriam rotundatus, subtus tumidus; apertura obliqua, subdiagonalis, magna, subovato-lunata; peristoma acutum, margine supero arcuato, columellari juxta perforationem verticali, breviter reflexo, perforationem partim tegente. Diam. maj. 14, min. 12, alt. 7 mm.

Hab. in insulâ 'Great Cocos' dictâ in sinu Bengalensi.

Near the Andaman *M. choinix*, but more tumid beneath, less flat above, and with much stronger spiral sculpture. For this shell I am indebted to Mr. Hugh Fulton. The Great Cocos is one of a group of islands between the Andamans and Cape Negrais in Arrakan.

MICROCYSTINA STUARTI Godwin-Austen MS. (Plate XXV. fig. 16.)

Testa imperforata, vel subperforata, convexo-depressa, pertenuis, nitida, politissima, minute, haud crebre, sub lente undique lineis parallelis striata, luteo-fusca; spira parum elevata, convexo-conoidea, sutura vix impressa; anfr. fere 5, plano-convexi, ultimus non descendens, ad peripheriam rotundatus, subtus convexus; apertura obliqua, lunata; peristoma tenue, margine columellari obliquo, superne in angulum prominentem, perforationem claudentem, dilatato. Diam. maj. 4.5, min. 4, alt. 2.5 mm.

Hab. in insulis Andamanicis (coll. G.-A.).

Near the Nicobar *M. rinki* Mörch, but smaller, rather thinner, more closely wound and imperforate.

MICROCYSTINA SHEVAROYANA, sp. nov. (Plate XXV. fig. 17.)

Testa aperte perforata, subumbilicata, conoideo-depressa, tenuis, translucens, polita, dense minute et subflexuose spiraliter undique sub lente striata, succinea; spira parum elevata, conoidea, sutura impressa; anfr. 6, superne convexi, ultimus ad peripheriam rotundatus, subtus convexusculus; apertura parum obliqua, lunata; peristoma tenue, marginibus supero basaliqve leviter arcuatis, columellari obliquo, obtuso, expansiusculo atque superne reflexiusculo, juxta perforationem angulatim dilatato. Diam. maj. 8.25, min. 7.5, alt. 4 mm.

Hab. in montibus Shevaroy dictis, Indiæ meridionalis (W. M. Daly).

Near the Ceylon *M. bintennensis* (*M. perfucata* var. *bintennensis* G.-A.), but distinguished by more open perforation, more numerous whorls, and paler colour. I am indebted to Mr. Hugh Fulton for specimens of this shell.

EUPLECTA PULCHELLA, sp. nov. (Plate XXV. fig. 18.)

Testa subobtectè perforata, conoideo-depressa, fere lenticularis, solidiuscula, succineo-cornea, decussatim striatula, superne sub lente liris obliquis flexuosis graniferis et lineis spiralibus impressis pulchre ornata, subtus glabra, polita; spira conoidea, apice obtuso, sutura impressa; anfr. 5, convexi, ultimus versus aperturam aliquanto descendens, ad peripheriam obtuse angulatus, infra convexus, circa perforationem compressus; apertura magna, diagonalis, rotundo-lunata; peristoma tenue, superne juxta anfractum penultimum arcuatum, margine columellari obliquo, expansiusculo, ad perforationem latius reflexo et incrassato. Diam. maj. 11·5, min. 10, alt. 6·5 mm.

Hab. in montibus Anaimalai dictis Indiæ australis (*Beddome*).

This shell, whilst in some respects recalling that of *E. layardi*, is distinguished by its large diagonal mouth and granular sculpture in flexuous transverse lines.

POLITA (?) *TURBINATA*, sp. nov. (Plate XXV. fig. 2.)

Testa aperte umbilicata, depressa, tenuis, pallide cornea, nitida, polita, sub lente minutissime spiraliter striata; spira convexa; anfr. 4½, convexi, ultimus undique rotundatus fere teres; apertura obliqua, rotundo-lunata, marginibus convergentibus; peristoma tenue, margine superiore arcuato, columellari vix superne verticali, regulariter curvato, haud reflexo. Diam. maj. 4·5, min. 4, alt. 2 mm.

Hab. in summis montibus Nilgiri dictis Indiæ meridionalis ad alt. 7000 ped. (*Beddome*).

This is a very near ally of the Ceylonese *Polita* ? *notabilis* Sykes. It is smaller and the aperture is more oblique.

EXPLANATION OF PLATE XXV.

Fig. 1. *Bensonia nepalensis*, nat. size, p. 441.

2. *Polita* (?) *turbinata*, nat. size and $\times 3$, p. 447.

3. *Taphrospira excavata*, nat. size, p. 442.

4. *T. compluvialis*, nat. size, p. 442.

5. *Macrochlamys kuluensis*, nat. size, p. 442.

6. *M. (?) atoma*, nat. size, and two views $\times 15$, also sculpture further enlarged, p. 443.

7. *M. superflua*, nat. size, p. 442.

8. *M. chaos*, nat. size, p. 444.

9. *M. prava*, nat. size and $\times 2$, p. 443.

10. *M. pseudochoinix*, nat. size, two views, p. 446.

11. *M. rutila*, nat. size, p. 443.

12. *M. spreta*, nat. size and $\times 3$, p. 445.

13. *M. curvilabris*, nat. size, and two views, $\times 3$, p. 445.

14. *M. noxia*, nat. size and $\times 2$, p. 444.

15. *M. patens*, nat. size, and two views $\times 3$, p. 445.

16. *Microcystina stuarti*, nat. size and $\times 3$, also basal and columellar margins of peristome further enlarged, p. 446.

17. *Microcystina shevaroyana*, nat. size, p. 446.

18. *Euplecta pulchella*, nat. size, and sculpture much enlarged, p. 447.

19. *Macrochlamys notha*, nat. size, p. 444.

5. On the Cranial Osteology of the Clupeoid Fishes. By
W. G. RIDEWOOD, D.Sc., F.Z.S., Lecturer on Biology
at St. Mary's Hospital Medical School, London.

[Received November 11, 1904.]

(Text-figures 118-143.)

INTRODUCTION.

In the spring of 1896, Prof. G. B. Howes suggested to me that an investigation on the structure of the skull in the lower Teleostean fishes would be a profitable piece of research, since there was every prospect of the results proving a valuable means of testing the validity of the existing schemes of classification of the fishes in question, and because an accurate knowledge of the structure of the skull in the lower Teleostean fishes was essential to a successful study of the remains of those extremely interesting extinct fishes which lie on the boundary-line between the Teleosteans and the Ganoids.

The investigation has proceeded slowly and intermittently, owing to repeated interruptions and to pressure of other work; but sufficient progress has now been made to allow of the publication of some of the results. Descriptions of the skulls of *Elops*, *Megalops*, and *Albula*, together with some general observations on the Teleostean skull, have already appeared in the 'Proceedings of the Zoological Society,' 1904, ii. pp. 35-81, and observations on the cranial osteology of the Mormyridæ, Notopteridæ, and Hyodontidæ in the Journal of the Linnean Society, xxix. 1904, pp. 188-217. A third paper, on the skull of the Osteoglossidæ, Pantodontidæ, and Phractolæmidæ, has just been completed, and has been offered to the Linnean Society; the present contribution deals with the skull of the Clupeoid fishes.

Eleven genera are considered in this paper, namely:—*Chirocentrus*, *Clupea*, *Pellona*, *Pellonula*, *Pristigaster*, *Hyperlophus*, *Chatoëssus*, *Dussumieria*, *Engraulis*, *Coilia*, and *Chanos*. A "Summary" of the observations and some "Comments" thereon are given on pp. 488-493.

Skulls of *Chirocentrus*, *Clupea*, *Chatoëssus*, *Engraulis*, *Coilia*, and *Chanos* were specially prepared for the purposes of the investigation, and were disarticulated according to the method explained in the 'Proceedings of the Zoological Society,' 1904, ii. p. 36; the other skulls examined are the property of the British Museum, and I take this opportunity of acknowledging my indebtedness to Mr. G. A. Boulenger for offering to me every facility in his power for the examination of the skulls under his charge.

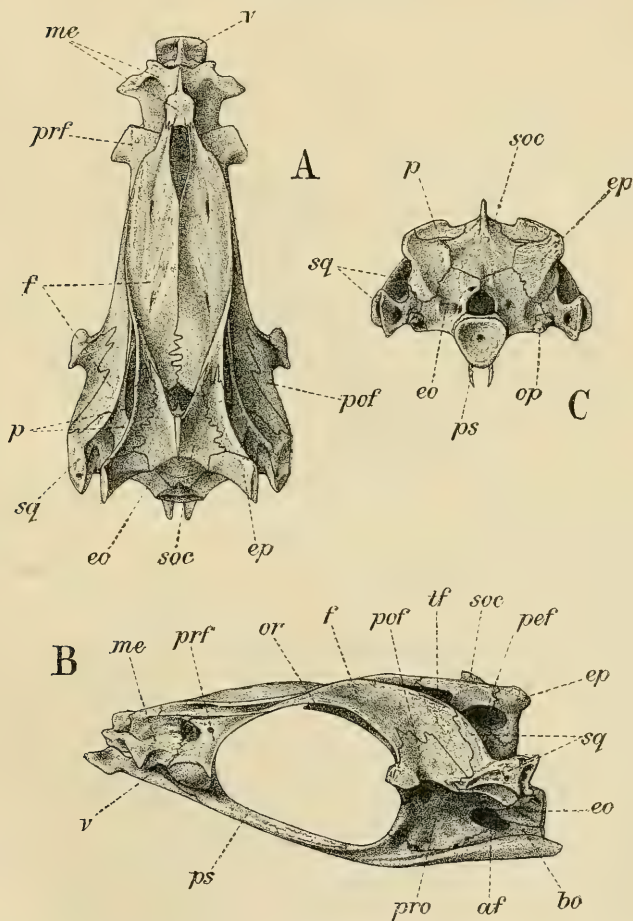
CHIROCENTRUS DORAB.

The only published figure of the skull of *Chirocentrus* that I have been able to discover is a not very serviceable sketch of

the hinder part of the cranium, seen from above, given by Klein (Jahresh. Ver. vaterl. Naturk. Württ. xli. 1885, pl. 3. fig. 82).

Material examined.—In addition to a skull (A) specially prepared for the purposes of this investigation from an alcohol-preserved specimen kindly furnished by Prof. Howes, two skulls were examined, one (B) belonging to a complete skeleton, marked 89.2.1.2059, in the Osteological Collection of the British Museum, and another (C) bearing no distinctive number.

Text-fig. 118.



Cranium of *Chirocentrus dorab*. A, dorsal view; B, left side; C, back view.
For explanation of lettering see p. 493.

Cranium (text-fig. 118).—The parietals are separated by the supraoccipital, and there is a small median fontanelle, divided
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longitudinally by a bar of cartilage, between the supraoccipital and the frontal bones (wanting, however, in specimen B), and another fontanelle between the anterior ends of the frontals. The posterior temporal groove is deep, but is not roofed over. The groove narrows away to a point anteriorly, and situated near its termination is a temporal foramen leading into the upper part of the cranial cavity. Behind the temporal foramen is a deep pre-epiotic fossa, bounded above and in front by the parietal, below by the squamosal, and behind by the epiotic, and terminating blindly against the deeper part of the supraoccipital. The lateral temporal groove above the postfrontal is wide and shallow.

The opisthotic is very small, and abuts on the squamosal, exoccipital, and pro-otic, but does not touch the epiotic. The pro-otic is extensive, and nearly reaches the back of the cranium. There is a small bulla, containing a vesicle of the swim-bladder, situated a little above the centre of the latero-ventral face of the pro-otic, and another bulla occurs in the squamosal and projects slightly above the floor of the posterior temporal groove. An auditory fenestra, bounded by the pro-otic, exoccipital, and basioccipital, is present in the side of the cranium.

At the front of the eye-muscle canal is situated a small basisphenoid, bounded laterally by processes of the alisphenoids which descend to meet the pro-otics. There is no descending part of the basisphenoid to bisect the eye-muscle canal. The parasphenoid projects a little behind the basioccipital, and has right and left posterior wings which bound the posterior outlet of the eye-muscle canal. At its anterior end, where it meets the vomer, the parasphenoid becomes considerably broader than in its middle part. The vomer projects in front of the mesethmoid, and neither it nor the parasphenoid bears teeth. The ethmoid region is comparatively short and well ossified, and there is no cartilaginous tract intervening between the mesethmoid and prefrontal. The two prefrontals are closely united in the median plane of the head.

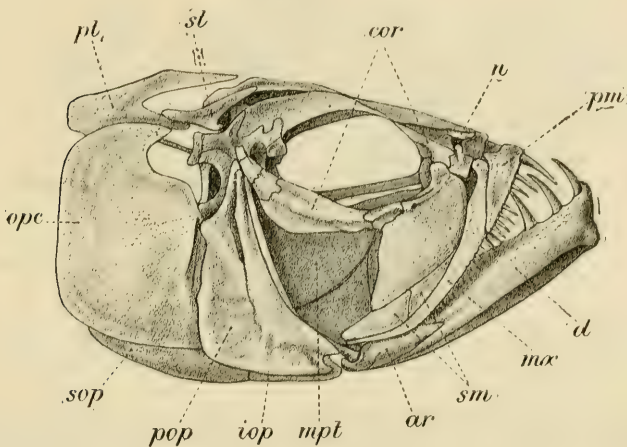
*Temporal and Preopercular Series** (text-fig. 119, p. 451).—The post-temporal is comparatively large and has three limbs. The upper one rests over the epiotic; the opisthotic limb is long, rod-like, and very slender; and the third, which is pointed and shorter than the other two, passes forward to touch the back of the supratemporal. The supratemporal is roughly triadate, and its antero-dorsal ray or limb is the largest; it forms a lateral wall to the unenclosed posterior temporal groove. The upper and lower limbs of the preopercular are set at a very wide angle. The interopercular has at its anterior end an ascending process which flanks the inner surface of the lower part of the symplectic.

* The reasons for including the preopercular and interopercular bones in this series, and for excluding them from the opercular and branchiostegal series, are given in a former paper (Proc. Zool. Soc. 1904, ii. pp. 68 and 75). For reasons given in the same paper, it is considered expedient to regard the post-temporal as a constituent of the skull.

Circumorbital Series (text-fig. 119).—The total number of circumorbital bones on each side is nine; the largest is that which lies antero-ventrally to the eye. The nasal is very small.

Maxillary Series (text-fig. 119).—Both premaxilla and maxilla bound the gape above. They both bear long, pointed teeth, and the anterior tooth of the premaxillary series is much larger than the others. As already noticed by Valenciennes (Hist. Nat. Poiss. xix. 1846, pp. 150, 152, and 154), the premaxilla is firmly attached to the maxilla in *Chirocentrus*, whereas in *Clupea* it is readily movable upon the maxilla. The two maxillæ meet one another in front of the mesethmoid, behind and above the premaxillary symphysis. There are two surmaxillæ.

Text-fig. 119.



Chirocentrus dorab, right side of skull. For explanation of lettering see p. 493.

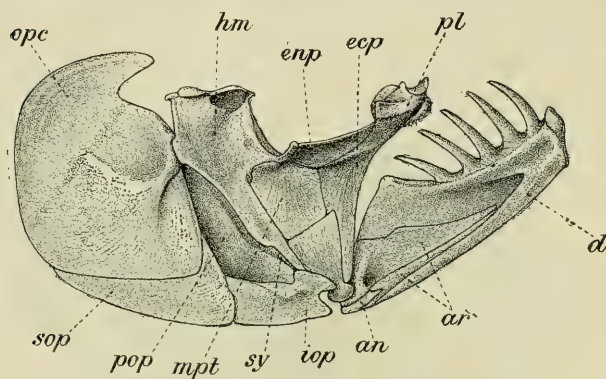
Mandibular Series (text-figs. 119 and 120, p. 452).—The dentary bears eight or ten large, curved, pointed teeth, four or five of which are firmly anchylosed to the bone*. The angular is distinct, and there is a very small sesamoid articular; the endosteal articular is not distinct from the ectosteal articular.

Hyopalatine Series (text-fig. 120, p. 452).—The hyopalatine arch is short and deep. The hyomandibular has a single broad head for articulation with the cranium. The metapterygoid extends high up the outer face of the hyomandibular, and the symplectic is small and lies nearly in a line with the axis of the hyomandibular. The symplectic, when viewed from the buccal aspect, is largely (not entirely) hidden by a downgrowth of the hyomandibular,

* Smith Woodward (Brit. Mus. Cat. Foss. Fishes, iv. p. 88) says of *Chirocentrus*: "Teeth firmly fixed in shallow sockets." He mentions, however, but one extinct species of *Chirocentrus* (*C. polyodon*), and states that it is "doubtfully of this genus."

and in an external view is barely visible between the quadrate and the preopercular. This concealment of the symplectic is utilised as a family character by Boulenger (Ann. Mag. Nat. Hist. (7) xiii. 1904, p. 164). The palatine is short and completely ossified, and has two distinct articular heads, one for the mesethmoid and vomer, and one for the prefrontal; its ventro-external surface enters into extensive synovial articulation with the maxilla. There are four or five minute teeth on the palatine, but none on the pterygoid bones.

Text-fig. 120.



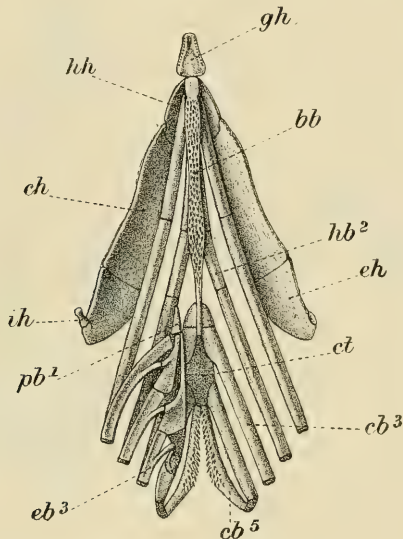
Chirocentrus dorab, hyopalatine arch, opercular bones, and mandible, left side, mesial aspect. For explanation of lettering see p. 493.

Opercular Series (text-figs. 119 and 120).—The opercular bone is of normal proportions; the subopercular is of small vertical extent, and has at its anterior end a strongly developed process rising against the anterior edge of the opercular. The branchiostegal rays are eight in number. The front four are shaped like the blade of a scythe, and there is a fairly regular transition in a backward direction to the larger and lamellate posterior members of the series. The first five are attached to the outer surface of the ceratohyal, and the other three to the outer surface of the epihyal.

Hyobranchial Series (text-fig. 121, p. 453).—The interhyal is ossified. The upper hypohyal is considerably smaller than the lower. The glossohyal is small and bears a few minute teeth on its superolateral edges. The first basibranchial is short, the second and third are exceptionally long. A long denticerous plate overlaps the three basibranchial bones, and a similar plate, of large size, but readily removable, and not shown in the figure, overlies the common cartilage of the fourth and fifth basibranchials. The dorsal parts of the branchial skeleton appear short in proportion to the ventral, but the disparity is probably to be accounted for

by the abnormal length of the latter. The first pharyngo-branchial is conical, fully ossified, and in a line with the first epibranchial; there is no spicular bone. The second pharyngo-branchial is triangular, and about $2\frac{1}{2}$ or 3 times as long as broad. The third pharyngobranchial is long; its anterior part is slender and rod-like, and runs along the mesial edge of the second pharyngobranchial.

Text-fig. 121.



Chirocentrus dorab, hyobranchial skeleton, dorsal view. The epibranchials and pharyngobranchials of the right side are not shown. For explanation of lettering see p. 493.

CLUPEA FINTA, etc.

In 1820 Weber (De Aure et Auditu Hominis et Animalium, pl. 8. figs. 64-66) gave three views of the cranium of the Herring, and a remarkably accurate description of the osseous bullæ that enclose the dilatations of the anterior end of the swim-bladder. Rosenthal's figures (Ichthyotomische Tafeln, Aufl. 2, Berlin, 1839, pl. 4) are moderately accurate, but of no particular value; and Brühl's figures (Vergl. Anat. aller Thierklassen, Abschn. 1, Skelettlehre der Fische, 1847, pl. 5, fig. 32 and pl. 10) are copied from those of Weber and Rosenthal. The figure of the skull of the Herring in the 'Histoire Naturelle des Poissons' of Cuvier and Valenciennes (pl. 593) is hardly worth mentioning. The side view of the complete skeleton of the Alose given by Agassiz in his 'Recherches sur les Poissons Fossiles' (Atlas, v. pl. L) is good, but only the superficial bones are seen, and none of them are named.

Hyrtl, in his paper on the Accessory Branchial Organ of Clupeoid Fishes (Denkschr. Akad. Wiss. Wien, x. 1855, pl. 1. figs. 2 and 3) has published figures of the branchial skeleton of *Clupea thryssa* (*Meletta thryssa*) and *Clupea matorocca* (*Alausa tyrannus*), but they are of little service in the present connection. Vrolik (Niederl. Arch. Zool. i. 3, 1873, pp. 268–270, and figs. 28 and 29) has given a short description and two figures of the cranium of the Herring; and Matthews has contributed a very complete account of the whole skull of that fish, with observations also on the skulls of *Clupea finta*, *Clupea pilchardus*, and *Clupea sprattus* (Fifth Rep. Fish. Bd. Scot. 1887, pp. 274–292, and figs. 15, 17, and 18). Three good figures of the cranium of the Herring appear in Fries' "Scandinavian Fishes" (ed. 2, by F. Smitt, vol. ii. 1895, p. 949).

Material examined.—The description below applies mainly to *Clupea finta*, but *Clupea harengus*, *Clupea sapidissima*, and *Clupea sprattus* were also examined. The hyobranchial skeleton described is that of *Clupea harengus*. All the skulls were specially prepared for the purposes of the investigation.

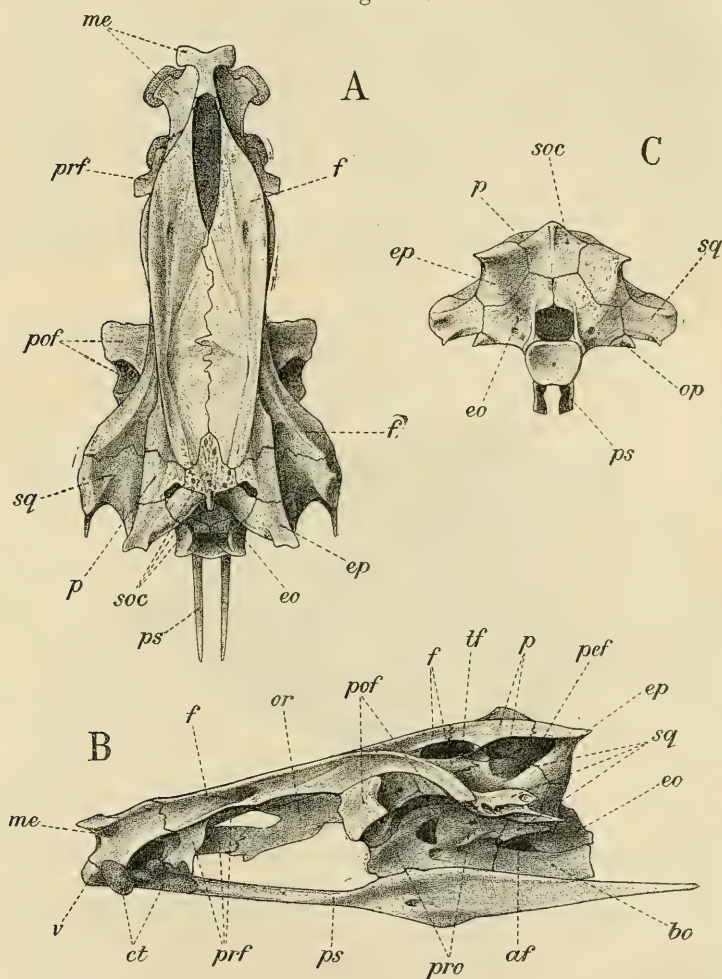
Cranium (text-fig. 122, p. 455).—The parietals are separated by the supraoccipital. The posterior temporal groove (*mastoid groove* of Fries, *l.c.*) is not roofed. Near its anterior end is an oval temporal foramen (Fries, *l.c.* p. 947), bounded by the parietal and frontal, and occupied by a fatty mass in the fresh fish, but leading directly into the cavum cranii in the dried skull; behind it is the pre-epiotic fossa, bounded by the parietal, squamosal, and epiotic, and ending blindly against the supraoccipital. The pre-epiotic fossa is relatively larger in *Clupea harengus* and *Clupea sprattus* than in *Clupea finta* and *Clupea sapidissima*.

In the middle of the pro-otic bone is a conspicuous bulla containing a spherical vesicle of the swim-bladder. A second bulla is present in the squamosal, but this is not visible in *Clupea finta* except by breaking open the bone; in *Clupea harengus* it is just visible on the surface. *Clupea sprattus* has no squamosal bulla (Matthews, *l.c.*, and Ridewood, Journ. Anat. and Phys. xxvi. 1891, p. 36, and fig. E, p. 32). In *Clupea harengus* the duct that leads through the exoccipital bone from the pro-otic and squamosal vesicles to the swim-bladder is dilated and fusiform in shape. The auditory fenestra, in the ventro-lateral aspect of the cranium, has an irregular outline; it is bounded by the pro-otic, exoccipital, and basioccipital, and leads into the perilymphatic cavity of the ear.

The episthotic is moderately small; it touches the pro-otic, squamosal, and exoccipital bones, but not the epiotic. The basisphenoid is small and transversely set, and its descending process is a mere spicule of bone which fails to reach the parasphenoid. The orbitosphenoid sends forward a process which meets a backwardly directed process of the united prefrontals. The parasphenoid is straight, or nearly so, in *Clupea finta*, but the middle part is slightly depressed in the other species examined.

The posterior wings, on the right and left sides of the posterior opening of the eye-muscle canal, are thin and delicate. They become separate from one another beneath the middle part of the pro-otic (they separate in front of the pro-otic in *Clupea harengus*),

Text-fig. 122.



Cranium of *Clupea finta*. A, dorsal view; B, left side; C, back view.
For explanation of lettering see p. 493.

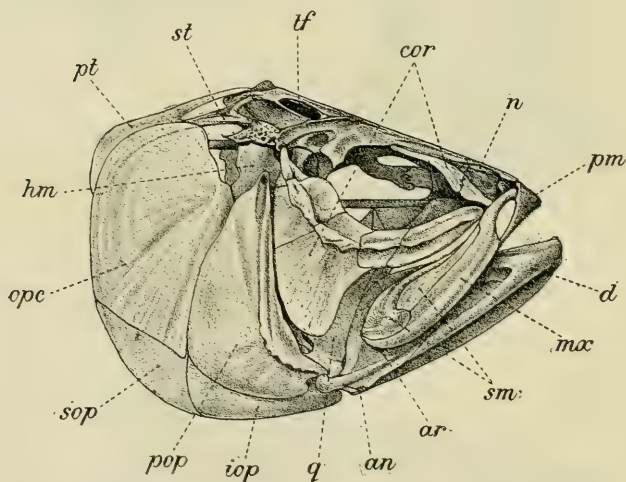
and extend a considerable distance behind the occiput. There are no teeth on the parasphenoid nor on the vomer in *Clupea finta*, but vomerine teeth are present in *Clupea harengus* and

Clupea sprattus. There is a median fontanelle between the mesethmoid and the frontal bones.

Temporal and Preopercular Series (text-fig. 123).—The post-temporal is rather large and slender. It has two long limbs attached to the epiotic and opisthotic respectively; the third limb, that which carries the sensory canal, is very short, and touches the back of the supratemporal. The supratemporal is elongated horizontally; its sensory canal, entering behind from the post-temporal, divides, as usual, into one branch going upward to the parietal and another which passes forward into the squamosal. The axis of the upright limb of the preopercular is more oblique in *Clupea harengus* than in *Clupea finta*, and the interopercular bone and the lower limb of the preopercular are relatively longer.

Circumorbital Series (text-fig. 123).—There are eight bones of this series—a small nasal, and seven bones disposed around the eye. The orbital ring is incomplete above.

Text-fig. 123.



Clupea finta, right side of skull. For explanation of lettering see p. 493.

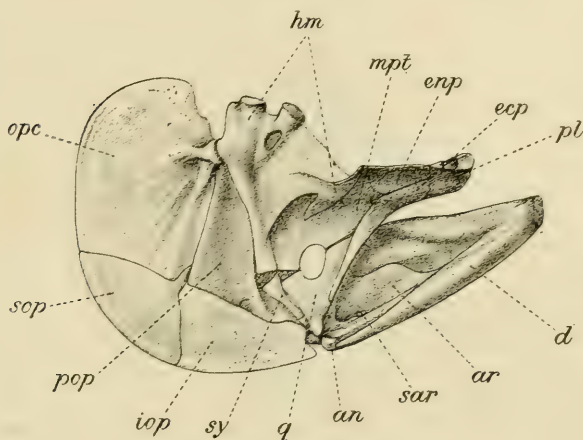
Maxillary Series (text-fig. 123).—The gape is bounded above by the maxilla and premaxilla, both of which bear a row of minute teeth along the lower edge. In *Clupea harengus* there are rarely more than three teeth in each premaxilla, but in *Clupea finta* the number is between twenty and thirty. Two surmaxillary bones are present on each side.

Mandibular Series (text-figs. 123 and 124, p. 457).—The mandible is rather high in proportion to its length, particularly so in *Clupea harengus*. In *Clupea finta* the highest point of the mandible lies

over the hinder half of the ramus; in *Clupea harengus* and *Clupea sprattus* it lies over the front half. The mandibular symphysis is more in advance of the premaxillæ in the two latter species than in the first. The angular bone is distinct. There is a small sesamoid articular in *Clupea finta*, but not in *Clupea harengus*. There are about five teeth situated in a row at the anterior end of the dentary in both species.

Hyopalatine Series (text-fig. 124).—As has been pointed out by Matthews (*l. c.* p. 289), the hyomandibular of *Clupea finta* articulates with the cranium by two distinct heads, whereas in *Clupea harengus* the hyomandibular has a single broad head. On comparing *Clupea finta* and *Clupea harengus*, the quadrate is seen to be more forwardly rotated in the latter, and the hyomandibular to slope more forward. The angle in the middle

Text-fig. 124.



Clupea finta, hyopalatine arch, opercular bones, and mandible, left side, mesial aspect. For explanation of lettering see p. 493.

of the ectopterygoid, also, is smaller, so that the forward displacement of the quadrate-articular joint does not affect the front part of the hyopalatine arch. It results, however, in the forward extension of the mandibular symphysis in front of the premaxillaries, and is accompanied by an elongation of the interopercular and the lower limb of the preopercular.

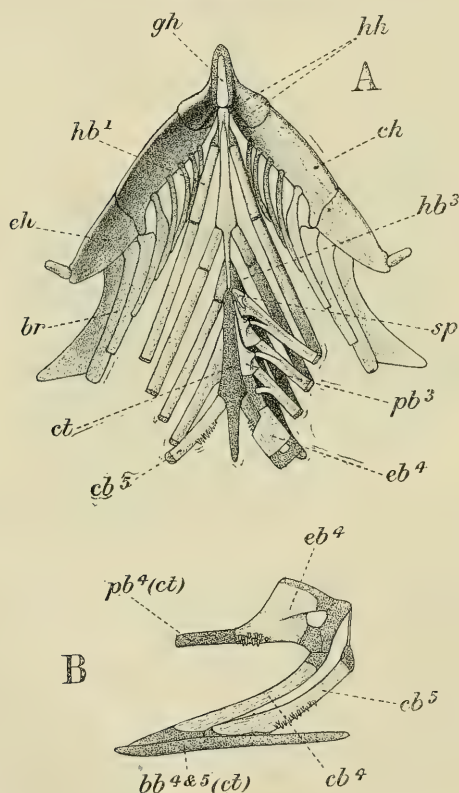
The symplectic is rather small in *Clupea finta*; it is relatively longer and more slender in *Clupea harengus*. The lower end of the symplectic of *Clupea finta* is abruptly terminated, and is not enveloped by the quadrate as is so generally the case. The palatine is shorter and broader in *Clupea finta* than in *Clupea harengus*, and has a distinct cartilaginous head for articulation with the prefrontal, whereas in *Clupea harengus* it is the pre-

frontal which has the boss of cartilage, the palatine merely offering a flat facet for articulation with it.

I fail to comprehend the meaning of Owen's remark (*Anat. Vert. i.* 1866, p. 117) that "in the Shad the palatine articulates with the premaxillary as well as the maxillary." The palatine does not touch the premaxilla in *Clupea finta*.

There are no teeth on the palatine or pterygoid bones in *Clupea finta*, but two or three minute teeth occur on the palatine of *Clupea harengus*, while in *Clupea sprattus* there is a row of minute teeth on the palatine, extending back even on to the entopterygoid. Matthews states (*l. c.* p. 291) that in the Sprat there are a few delicate teeth on the metapterygoid. These I have failed to discern.

Text-fig. 125.



Clupea harengus. A, hyobranchial skeleton, dorsal view. The epibranchials and pharyngobranchials of the left side are not shown. B, fourth and fifth branchial arches of the right side, mesial aspect, more enlarged than fig. 125 A. For explanation of lettering see p. 493.

Opercular Series (text-figs. 123 and 124, pp. 456, 457).—The opercular and subopercular bones are of average proportions; the latter is relatively larger in *Clupea harengus* than in *Clupea finta*. There are seven branchiostegal rays in *Clupea finta*—five rather slender ones borne by the ceratohyal, and two broader ones attached to the outer face of the epihyal. In *Clupea harengus* the numbers are five and three respectively.

Hyobranchial Series (text-fig. 125, p. 458).—The lower hypohyal of *Clupea harengus* is larger than the upper. The urohyal is large and extends back behind the posterior extremity of the third basibranchial. The glossohyal is a conical cartilage, flanked on its upper surface by a thin membrane-bone. This is covered by mucous membrane bearing small teeth; but the teeth, although they may leave scars when removed, are not intimately attached to the bone. The only elements of the hyobranchial skeleton which bear teeth ankylosed with the bone are the fifth ceratobranchials.

The second basibranchial bears fixed on its upper surface a toothless membrane-bone which extends forward and backward over, but is readily removable from, the first and third basibranchials. The equivalent membrane-bone in *Clupea finta* does not extend over the third basibranchial. The fourth and fifth basibranchials are represented by an elongated cartilage which is continued back in the form of a slender rod some distance behind the point at which the fifth ceratobranchials are attached.

The fourth epibranchial is rather large and flat, and serves to support the wall of the epibranchial organ. Its posterior extremity is united with the upper end of the fifth ceratobranchial by a ligament which is the exact equivalent of that slender bar of cartilage which in *Engraulis* represents the fifth epibranchial (*cf.* text-figs. 125 B and 135 B, pp. 458 and 475). In *Clupea alosa* Gegenbaur (Morph. Jahrb. iv. Suppl. p. 24 and pl. ii. fig. 13, *Clupea vulgaris* or *Alosa vulgaris*) has figured a fifth epibranchial cartilage. The first pharyngobranchial is small and cartilaginous, but a well-developed spicular bone rises vertically from the upper surface of the anterior extremity of the first epibranchial.

PELLONA MOTIUS.

In *Pellona motius* (Brit. Mus. 1888.11.6.64, E. C. Madras) the top of the cranium is much narrower than in *Clupea*, and the two principal longitudinal ridges on the upper surface are closer together and more nearly parallel. The part of the cranium behind the orbit is greatly reduced in an antero-posterior direction, but not in a vertical direction. The temporal foramen is smaller than in *Clupea* and the pre-epiotic fossa shallower.

The pro-otic, squamosal, and exoccipital appear to be completely hollowed out for the accommodation of the caecal diverticula of the swim-bladder; but the exact relations of the bullae can only be made out by freely incising the hinder part of the cranium,

which in the circumstances was not permissible. The pro-otic bulla is elongated in a direction transverse to the axis of the skull, and in a posterior view of the cranium a portion of the squamosal bulla is visible on the mesial side of the descending ridge of the epiotic bone. An auditory fenestra is present.

The opisthotic bone is small and flat; the orbitosphenoid does not extend to the prefrontals; and there is no distinct fenestra between the mesethmoid and the frontal bones, although the anterior ends of the right and left frontal bones are separated by a narrow space. The parasphenoid has the same relations as in *Clupea*; there are no teeth on the parasphenoid and vomerine bones.

The post-temporal and supratemporal bones resemble those of *Clupea*, except that both are relatively shorter. There is a small nasal on each side of the head, and seven bones around the eye.

Vestigial teeth occur on the edges of the premaxilla and maxilla. The maxilla and two surmaxillæ are of greater vertical extent and less horizontal extent than in *Clupea*. The mandible is rather short and high, and the highest point is over the middle of the length of the ramus. The angular bone is small and distinct. There are six or eight minute teeth at the front of each dentary bone.

The hyomandibular articulates with the cranium by a single broad head. The ectopterygoid is sharply bent, even more so than in *Clupea harengus*. The buccal surfaces of the entopterygoid, ectopterygoid, and palatine are covered with a kind of shagreen of closely-set, minute denticles.

The bones of the opercular series are much the same as in *Clupea harengus*, but they are relatively smaller. The interhyal is ossified. The urohyal has the form of a thin, triangular plate of considerable vertical extent.

The fourth epibranchial is relatively less expanded than in *Clupea*. The three basibranchial bones, the glossohyal, and the first and second hypobranchials are covered with a shagreen of denticles similar to that found on the entopterygoid.

PELLONULA VORAX.

Pellonula vorax (Brit. Mus. 89.11.20.11, Stanley Falls) has a skull which bears a fairly close resemblance to that of the Herring. The upper surface of the cranium is smoother, and the part of the cranium behind the orbit relatively shorter. The bony bullæ resemble those of *Pellona* rather than those of *Clupea*, and a portion of the squamosal bulla is visible in a posterior view of the cranium on the mesial side of the descending ridge of the epiotic bone. The exoccipitals and basioccipital were not present in the specimen examined, so that the presence of an auditory fenestra could not be determined.

The orbitosphenoid does not extend to the prefrontals. A

median fontanelle occurs between the mesethmoid and the frontal bones. There are no teeth on the parasphenoid and vomer.

The relations of the post-temporal are the same as in *Clupea*, but the bone is shorter; the vertical limb of the supratemporal is longer than the horizontal limb.

Each premaxilla bears about eight fairly large and pointed teeth, but the maxilla is edentulous. The highest point of the mandible is in advance of the middle of the length of the ramus. At the front of the dentary are five or six rather long, pointed teeth, smaller, however, than those of the premaxilla. The angular bone is distinct.

There is a single row, in places a double row, of small teeth running along the middle of the convex surface of the entopterygoid, and a row of about six larger teeth, as large as those of the dentary, set transversely across the front of the palatine.

There are six branchiostegal rays on each side; those which are attached to the ceratohyal resemble in shape the branchiostegal rays of the Anchovy rather than those of the Herring, *i. e.* they are not curved rods, but have the form of plates, each with a conspicuous antero-ventral projection.

PRISTIGASTER TARTOOR.

Pristigaster tartoor (Brit. Mus. 1889.2.1.2026, Malabar, F. Day) has a high, narrow skull, partaking of the general lateral compression of the body. The parietal bones are separated; the temporal grooves are shallow, as in *Clupea*; there is a temporal foramen and an auditory fenestra. In the squamosal bone is a spherical vesicle of the swim-bladder, the bony envelope of which projects into the large shallow pre-epiotic fossa. The vesicle in the pro-otic is much larger than that in the squamosal bone, and its bony envelope bulges upon the ventro-lateral face of the pro-otic, and also projects in two places on the anterior or orbital face of the pro-otic bone.

There is a small opisthotic bone, a small basisphenoid, and an orbitosphenoid; the orbitosphenoid extends forward towards the prefrontals, but fails to reach them. There are right and left posterior wings to the parasphenoid, and the eye-muscle canal opens between them.

The post-temporal has three limbs; the anterior or supratemporal limb is unusually long, the deep or opisthotic limb is long and slender. The supratemporal is triradiate, and the upright ray, passing to the parietal bone, is longer than the other two. The upright limb of the preopercular is about twice as long as the horizontal limb, and makes with it an angle of 130 degrees.

The nasal is a small, tubular bone. Around the orbit are seven bones: two narrow postorbitals, two suborbitals, the second larger than the first, two preorbitals, the lower larger than the

upper, and a long tapering bone lying antero-dorsally to the orbit. The gape is small, and its upper margin is formed almost entirely by the premaxillæ, although these are small bones, while the maxillæ are large. A single row of minute teeth occurs along the edge of the premaxilla, and these are met by a similar row along the sharp front edge of the dentary. The ventral edge of the maxilla is provided with a single row of teeth, but, as in *Clupea*, these do not bite against any mandibular teeth. There are two surmaxillæ above each maxilla.

The angular bone is distinct from the articular. The ventral surfaces of the palatine and entopterygoid bones are extensively covered with minute teeth; there are no teeth on the vomer. The subopercular is reduced in size; the branchiostegal rays are five or six in number on each side. A spicular bone is present, and has the form of an upright rod which broadens out at its lower end.

HYPERLOPHUS COPII.

The genus *Diplomystus* was established by Cope in 1877 (Bull. U.S. Geol. Geog. Surv. Territ. iii. 1877, p. 808) for certain extinct species of fish allied to *Clupea*, but differing in the possession of "a series of dorsal scuta, which extend from the supraoccipital region to the base of the dorsal fin." The genus has since been found to be represented at the present day by species living in the rivers of New South Wales and Chili.

The generic name *Diplomystus* is, I understand from Mr. Boulenger, preoccupied by a Siluroid fish, or, to be more exact, the name of this Siluroid (*Diplomyste*, Duméril; *Diplomystes*, Bleeker; *Diplomystax*, Günther) so closely resembles the name *Diplomystus* as to render the latter invalid. In such case the wisest plan is to apply to "Herrings with occipito-dorsal serrature" the name *Hyperlophus*, as suggested by Ogilby in 1892 (Rec. Austral. Mus. ii. 1892, p. 26).

The specimen examined is one in the British Museum Collection, prepared from a fish about $3\frac{1}{2}$ inches in length, and marked "*Hyperlophus copii*, 97.10.27.38, N. S. Wales, Ogilby."

The parietal bones are separated; the temporal grooves are as in *Clupea*; a temporal foramen is present and an auditory fenestra. The pre-epiotic fossa is present, but with the exception of its upper part it is largely obliterated by the bulging of the squamosal bulla. The vesicle of the swim-bladder in the pro-otic bone is large, and its bony envelope projects upon the ventrolateral face of the pro-otic. The opisthotic is small; the basisphenoid cannot be recognised in the specimen under consideration; the orbitosphenoid extends forward to meet the prefrontals. There are right and left posterior wings of the parasphenoid, and the eye-muscle canal opens between them.

The post-temporal has an epiotic and an opisthotic limb, but no supratemporal limb. The supratemporal is triradiate, and the ray which passes to the parietal is longer than the other two.

The upright and horizontal limbs of the preopercular are about equal in length, and enclose an angle of 100 degrees. The nasal bone is small and tubular; there is a postorbital bone of moderate size, two suborbitals, two preorbitals, the upper one smaller than the lower, and a narrow bone lying antero-dorsally to the orbit.

The gape is so small that, although the premaxilla is small and the maxilla large, the latter forms only a small portion of the oral border when the mouth is opened to its widest extent. There is but a single surmaxilla*, which from its shape and position is clearly to be identified with the posterior of the two present in *Clupea*. The angular bone is distinct. The mandibular ramus stands high, and the highest point is situated far forwards; the outline of the ramus is intermediate between that of *Clupea harengus* and that of *Chatoëssus* (text-fig. 128, p. 466). There are no teeth on the dentary, and none on the premaxilla, maxilla, palatine, entopterygoid, ectopterygoid, and vomer.

The opercular bones are normal; there are five branchiostegal rays on each side; the interhyal is bony; there are two hypohyals, the lower larger than the upper. The glossohyal is long, narrow, with minute teeth; the urohyal is large and extends backward considerably behind the posterior limit of the epihyal.

CHATOËSSUS EREBI.

Material examined.—In addition to a skull specially prepared for the purposes of this investigation from an alcohol-preserved specimen kindly furnished by Prof. G. B. Howes, two skulls were examined, belonging to complete skeletons in the Osteological Collection of the British Museum (67.5.6.99 and 67.5.6.5, both from Cape York, N. Australia).

Cranium (text-fig. 126, p. 464).—The cranium is stout and rather broad, and is remarkable for the spines that project from the squamosal, postfrontal, and prefrontal bones. The middle part of the parasphenoid is greatly depressed, which gives an appearance of considerable depth to the middle of the cranium.

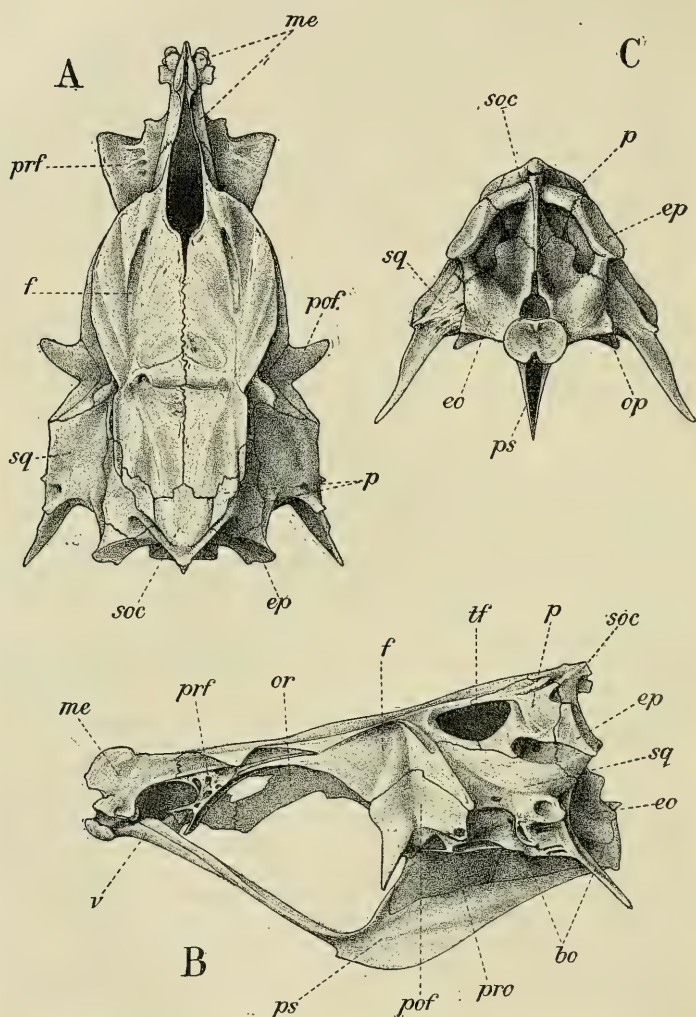
The parietals are separated by the supraoccipital. There is an oval temporal foramen, situated near the anterior end of the posterior temporal groove, bounded by the frontal and parietal, and leading directly into the cranial cavity. Behind this, and at a slightly lower level, is a deep pre-epiotic fossa, bounded above by the parietal and epiotic, and below by the squamosal and epiotic. It extends inward and upward as far as the supraoccipital.

There is a subspherical cavity in the pro-otic, and another, rather larger, in the squamosal, for the accommodation of vesicles of the swim-bladder; but since these do not appear as bullate projections on the surfaces of the bones, it is necessary to dissect

* Smith Woodward (Brit. Mus. Cat. Foss. Fishes, iv. p. 139) records *Diplomystus* as having two surmaxillæ. There is a possibility that one surmaxilla had been lost from each side of the skull examined by me before it came into my hands, but from the appearance of the maxillary series of bones I do not think that this is at all likely.

the skull to determine their presence. The opisthotic is moderately small, and more ventral than posterior in position; it touches the pro-otic, squamosal, and exoccipital, but is remote from the

Text-fig. 126.



Cranium of *Chatoëssus erebi*.—A, dorsal view; B, left side; C, back view.

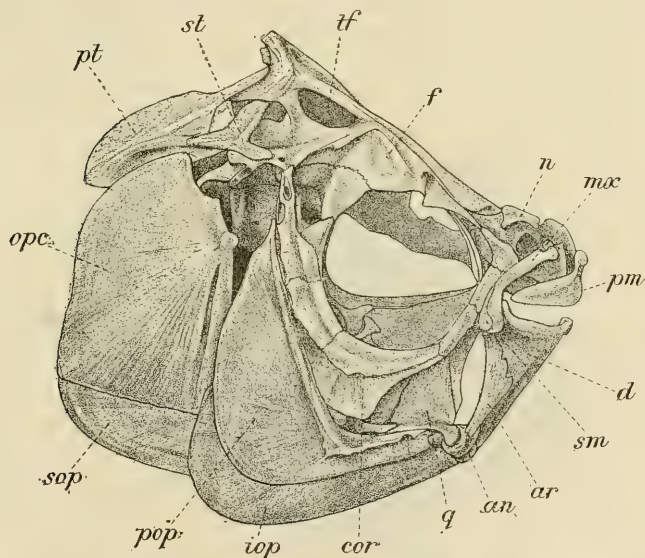
For explanation of lettering see p. 493.

epitotic. An auditory fenestra is present, bounded by the pro-otic, exoccipital, and basioccipital. At the back of the cranium are

two depressions, bounded externally by the epiotics. The epiotic has on its postero-superior surface a large, oval, smooth facet for articulation with the post-temporal; and from the apex of the epiotic there projects backward into the muscles of the trunk a separable osseous brush. A similar brush projects back from the apex of the supraoccipital, which has no crest or spine.

The parasphenoid extends very nearly to the posterior end of the basioccipital, and although the right and left sides of the posterior outlet of the eye-muscle canal are formed by vertical laminae of the parasphenoid, there are no projecting posterior wings of this bone. The middle portion of the parasphenoid bears a sharp ventral keel. Neither parasphenoid nor vomer bears teeth. A small basisphenoid is present, but it has no descending portion bisecting the eye-muscle canal. The orbitosphenoid is fairly large, and has a forwardly directed process that meets a backward growth of the combined prefrontals. A fontanelle is present in the roof of the skull between the mesethmoid and the frontals.

Text-fig. 127.



Chatoëssus erebi, right side of skull. For explanation of lettering see p. 493.

Temporal and Preopercular Series (text-fig. 127).—The post-temporal is large, and the attachment of its upper limb to the postero-superior surface of the epiotic is quite intimate, and not by means of a broad loose ligament. The deep limb is rod-like and is attached to the back of the opisthotic. The third limb is

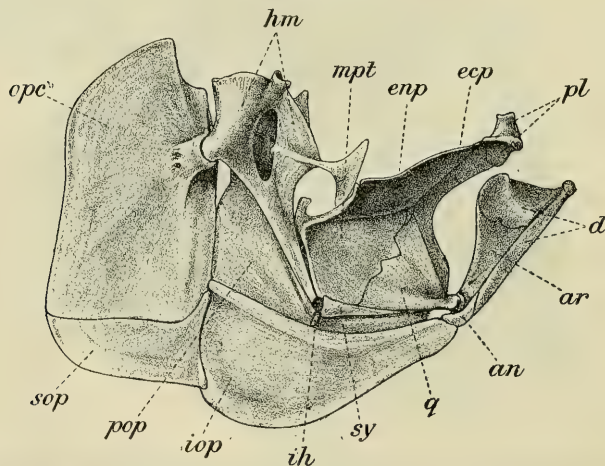
very short and is united with the back of the supratemporal. The supratemporal has the usual triradiate arrangement of the sensory canal.

The horizontal limb of the preopercular is a little more than half as long as the upright limb, and makes with it an angle of about 95 degrees. The interopercular is large, considerably larger than the subopercular, and comes into direct contact with the angular bone, without the intervention of the usual ligament.

Circumorbital Series (text-fig. 127, p. 465).—There are nine bones of this series. The nasal is roughly rectangular in shape, with a narrow tube for the sensory canal passing lengthwise over its surface. The form and relations of the other bones are readily to be comprehended by a glance at text-fig. 127.

Maxillary Series (text-fig. 127, p. 465).—The gape is very small and bounded above by the premaxillæ. The maxilla is only slightly longer than the premaxilla. Fries (Scand. Fishes, ed. 2, ii. 1895, p. 952) states that the premaxilla is longer than the maxilla in the Chatoëssinae, but such is not the case in the specimens now under consideration. The front part of the maxilla is of considerable vertical extent, and the posterior extremity is also expanded. The premaxilla is flattened and scale-like, with a sharp lower edge. Neither maxilla nor premaxilla bears teeth. A single surmaxilla of small size is present on each side.

Text-fig. 128



Chatoëssus erebi, hyopalatine arch, opercular bones, and mandible of left side, mesial aspect. For explanation of lettering see p. 493.

Mandibular Series (text-figs. 127 and 128).—The remarkable shape of the mandible is doubtless due to the reduction of the gape not being accompanied by an adequate forward displacement of the quadrate-articular joint. The coronoid process thus comes

to lie over the anterior half of the ramus; it is formed mainly, but not entirely, by the dentary. The angular is distinct. There are no teeth.

Hyopalatine Series (text-fig. 128, p. 466).—The hyomandibular articulates with the cranium by two heads: a small anterior and a broad posterior one. It is long, and its axis slopes forward and makes an angle of about 110 degrees with the symplectic, which is disposed almost horizontally. The extremity of a triangular process which rises upward and forward from the external face of the hyomandibular lies over the outer surface of the postfrontal spine, and forms with it a kind of sliding joint. The palatine is very short and broad, and has a single head for articulating with the ethmoid region of the cranium. There are no teeth.

Opercular Series (text-figs. 127 and 128, pp. 465, 466).—The opercular and subopercular bones are of average proportions. The branchiostegal rays are six in number; the first three are rather slender and closely set, and situated some distance in advance of the other three, which are greatly expanded and overlap the former three. The first four are attached to the outer edge of the ceratohyal, the fifth lies over the suture between the ceratohyal and epihyal, while the last is attached to the outer edge of the epihyal.

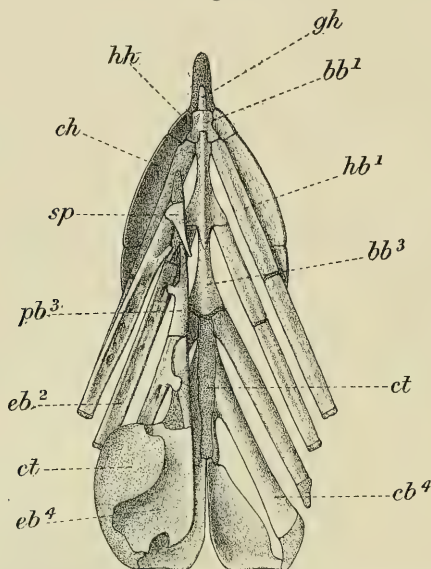
Hyobranchial Series (text-fig. 129, p. 468).—The hyoid is short, so short, indeed, that the end of the epihyal is only slightly behind the end of the first hypobranchial. The lower hypohyal is about twice as large as the upper. The glossohyal consists of a stout rod of cartilage, with a small membrane-bone on the posterior part of its upper surface. The urohyal is a strong bone, the sections of the posterior half of which have the form of an inverted Y. The third basibranchial is nearly as large as the second, and the cartilage that represents the fourth and fifth basibranchials is drawn out to a considerable length.

Concerning *Chatoëssus* Günther states ('Study of Fishes,' 1880, p. 657) that the branchial arches form two angles, one pointing forwards and the other backwards. This statement, which appears to be based upon the description given by Valenciennes (Hist. Nat. Poiss. xxi. 1848, p. 96), does not, I believe, refer to the skeletal arches as one might suppose on reading the passage, but is an allusion to the remarkable continuation of the series of gill-filaments from the top of the epibranchials, particularly the first, backward along the side of the parasphenoid.

The anterior ends of the fourth ceratobranchials are expanded both forwards and backwards, so that while not relinquishing their connection with the anterior ends of the fifth ceratobranchials, they nearly touch the mesial ends of the third ceratobranchials. The fifth ceratobranchials are considerably expanded, as also are the fourth epibranchials. The latter have a curved wall of cartilage extending upward and inward from the outer edge of the bone, in relation with the epibranchial organ.

In the first two branchial arches the epibranchial is longer than the ceratobranchial, but in the third the reverse is the case. The third hypobranchials are small and concealed in a dorsal view by the breadth of the posterior end of the third basibranchial.

Text-fig. 129.



Chatoëssus erebi, hyobranchial skeleton, dorsal view.—The epibranchials and pharyngobranchials of the right side are not shown. For explanation of lettering see p. 493.

Whereas in most forms the fourth pharyngobranchial is represented by a cartilage with a removable dentigerous membrane-bone on its ventral surface, in *Chatoëssus* the membrane-bone (devoid of teeth) flanks the cartilage on three sides, ventral, mesial, and dorsal, and simulates an ossified fourth pharyngobranchial. The first pharyngobranchial is cartilaginous, and a large spicular bone is present. There are no teeth on any part of the hyobranchial skeleton.

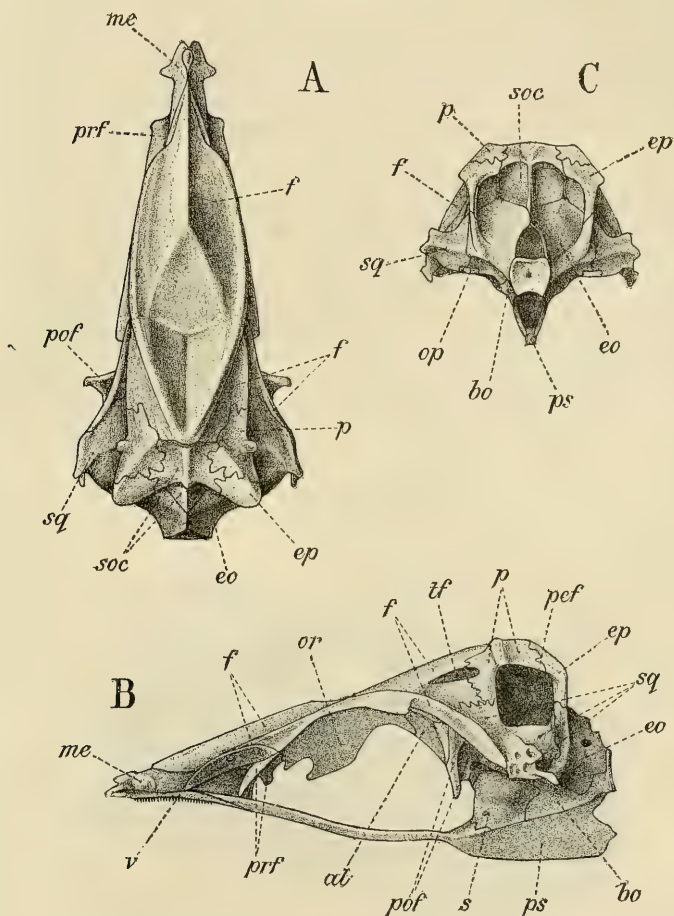
DUSSUMIERIA ACUTA.

Material examined.—In addition to a skull specially prepared for the purposes of this investigation from an alcohol-preserved specimen from Madras kindly furnished by Mr. G. A. Boulenger, another skull was examined, belonging to a complete skeleton in the Osteological Collection of the British Museum (Brit. Mus. 1889.2.1.2038, Bombay).

Cranium (text-fig. 130, p. 469).—The cranium has all the cha-

racteristic features of that of *Clupea*. The posterior temporal groove faces more laterally than in *Clupea* owing to the width of the cranium in the squamosal region being proportionately less. The temporal foramen near the anterior end of the groove is a

Text-fig. 130.



Cranium of *Dussumieria acuta*.—A, dorsal view; B, left side; C, back view.
s, point of attachment of the spicular bone to the pro-otic. For explanation of other lettering see p. 493.

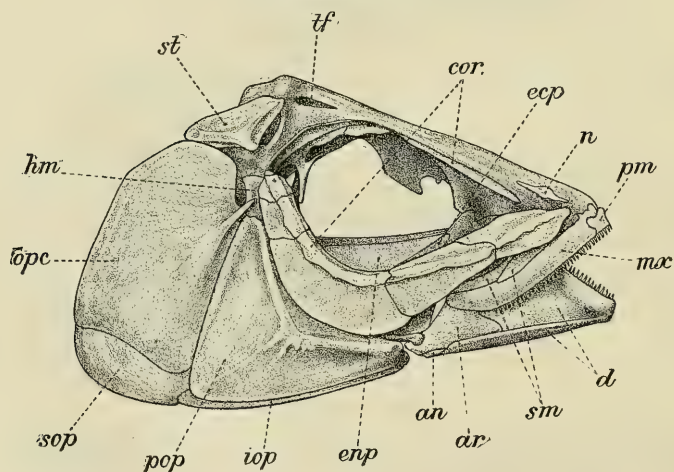
narrow horizontal slit, but the pre-epiotic fossa is large. This fossa is bounded above by the parietal, below by the squamosal, in front by the parietal and squamosal, and behind by the epiotic. It is about half as deep as wide, and the inner wall is mainly

membranous, but partly formed by lamellar extensions of the supraoccipital, epiotic, and squamosal bones.

There is an auditory fenestra between the pro-otic, exoccipital, and basioccipital. A large osseous bulla, enclosing a terminal vesicle of the swim-bladder, occurs in the pro-otic, and another in the squamosal. The bony envelopes of the horizontal and posterior vertical semicircular canals are very prominent; the former is conspicuous on the hinder part of the squamosal bulla, the latter forms the posterior vertical edge of the epiotic and exoccipital. The posterior depression lying to the mesial side of this edge is rather deep. A small opisthotic bone is present. The supraoccipital has no crest and separates the two parietal bones.

The posterior third of the length of the parasphenoid consists of a pair of parallel laminae bounding the sides of the eye-muscle canal. A process of the alisphenoid runs along the basal portion of the anterior edge of the postfrontal spine, which is not the case in *Clupea*. A basisphenoid is present, but it has no vertical part descending towards the parasphenoid. The orbitosphenoid is produced forward to meet the back of the combined prefrontals. The vomer is strap-shaped and bears a long median row of teeth which Valenciennes (Hist. Nat. Poiss. xx. 1847, p. 468) failed to notice. There is no dorsal fontanelle between the mesethmoid and the frontals.

Text-fig. 131.



Dussumieria acuta, right side of skull. For explanation of lettering see p. 493.

Temporal and Preopercular Series (text-fig. 131).—The post-temporal has a long limb resting upon the epiotic prominence, a shorter, rod-like limb attached to the back of the opisthotic, and

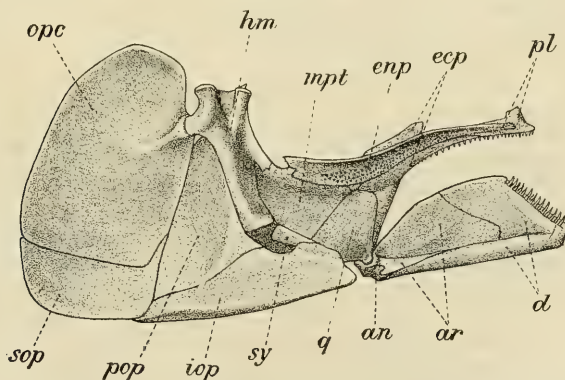
a still shorter lamellar limb overlapped by the back of the supratemporal. The supratemporal forms a kind of outer wall to the large pre-epiotic vacuity. There is also a pair of ordinary body-scales, about as large as the supratemporals, which project back from the transverse ridge of the parietals. These, together with the supratemporals and the preoperculars, form a kind of girdle around the top and sides of the hinder part of the head. The preopercular is triangular in shape, with a concave anterior border; the horizontal limb is more than half as long as the upright limb, and makes with it an angle of about 100 degrees.

Circumorbital Series (text-fig. 131, p. 470).—This series consists of seven bones: a small nasal, a long narrow bone overlying the prefrontal, and five others of moderately large size.

Maxillary Series (text-fig. 131, p. 470).—The premaxilla is unusually short, and has the form of a flat, square scale, overlapping the anterior portion of the maxilla, and with teeth along its lower edge. The maxilla is fairly long and is toothed along the whole length of its lower edge. There are two surmaxillæ.

Mandibular Series (text-figs. 131 and 132).—The mandible closely resembles that of the Herring, and the highest point lies over the anterior half of the ramus. Long, curved, pointed teeth, similar to those of the maxilla and premaxilla, occur along the antero-superior edge of the dentary. The angular bone is separate; there is no distinct sesamoid articular.

Text-fig. 132.



Dussumieria acuta, hyopalatine arch, opercular bones, and mandible of left side, mesial aspect. For explanation of lettering see p. 493.

Hyopalatine Series (text-fig. 132).—The hyomandibular has two distinct heads for articulation with the cranium, the posterior slightly larger than the anterior. The symplectic makes an angle of about 125 degrees with the axis of the hyomandibular; it is flat, and is largely overlapped on its inner surface by the inter-

opercular. The palatine, ectopterygoid, and entopterygoid bear teeth. The ectopterygoid has an outwardly projecting ledge which serves to support the eyeball, and which comes into close relation with the upper edge of the middle of the three large bones of the suborbital series. The ectopterygoid is curved in the middle of its length, but not sharply bent.

Opercular Series (text-figs. 131 and 132, pp. 470, 471).—The gill-cover is large, and the opercular and subopercular bones are of corresponding proportions. The branchiostegal rays are thirteen in number; eight of these are set on the outer side of the lower edge of the ceratohyal, and five on the epihyal. The shape is approximately the same in all, but the hinder ones are larger than those in front. Valenciennes (Hist. Nat. Poiss. xx. 1847, p. 469) and Günther (Brit. Mus. Cat. Fish. vii. 1868, p. 466) put the number of branchiostegal rays as fifteen.

Hyobranchial Series.—The lower hypohyal is slightly larger than the upper. The posterior one-third of the glossohyal cartilage is ossified; a narrow membrane-bone with a row of teeth along the middle covers the whole. The first, second, and third basibranchials are covered by separate membrane-bones, each bearing a narrow central row of teeth, but the investing lamina of the second basibranchial extends forward over the hinder part of the first basibranchial. The urohyal is long and slender. The fourth epibranchial is about as much expanded as in the Herring. The first pharyngobranchial is cartilaginous, and a spicular bone rises from the front end of the first epibranchial, and is attached by ligament to the pro-otic at the point marked *s* in text-fig. 130 B, p. 469.

ENGRAULIS ENCRASICHOLUS.

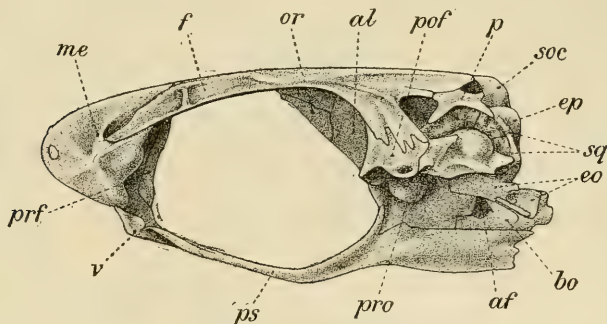
The chondocranium of a young Anchovy of 25 mm. length has been described and figured by Pouchet (Journ. Anat. et Phys. 1878, p. 75, and figs. 49 and 50), but the account has no important bearing in the present connection.

Cranium (text-fig. 133, p. 473).—The most remarkable feature about the general aspect of the cranium is the considerable vertical extent of the orbital region, a feature directly related to the large size of the eyes. The parietals are separated, and on the roof of the cranium is a pair of fontanelles, each bounded by the frontal, parietal, and supraoccipital. On the upper surface of each frontal bone are two cross bars or arches of bone, the anterior one strictly transverse, the second oblique.

A distinct opisthotic is not present; the deep or opisthotic limb of the post-temporal is attached to a process of the exoccipital lying immediately over the foramen for the tenth nerve. The posterior temporal groove is shallow, and the temporal foramen, near its anterior end, is large and bounded by the frontal and parietal, with sometimes also a small portion of the squamosal below. Owing to the large size of the squamosal bulla that

encloses a vesicle of the swim-bladder, the pre-epiotic fossa above it is rendered very shallow as compared with that of *Clupea*. The auditory fenestra, opening into the perilymphatic cavity, is bounded by the pro-otic, exoccipital, and basioccipital, as in *Clupea*.

Text-fig. 133.



Cranium of *Engraulis encrasicolus*, left side. For explanation of lettering see p. 493.

The foramen for the trigeminal nerve is of large size; it faces more anteriorly than usual, and is bounded by the alisphenoid and pro-otic, instead of by the pro-otic alone. The pro-otic bulla, like that of the squamosal, is large; it is not spherical, but is drawn out in a direction nearly at right-angles to the median plane of the head (see Journ. Anat. and Phys. xxvi. 1891, p. 36, and p. 32, fig. D). A basisphenoid is present, but it has no descending limb. The articulation for the hyomandibular is situated rather far forward; the anterior head of the hyomandibular articulates with the postfrontal, and the hinder with the squamosal.

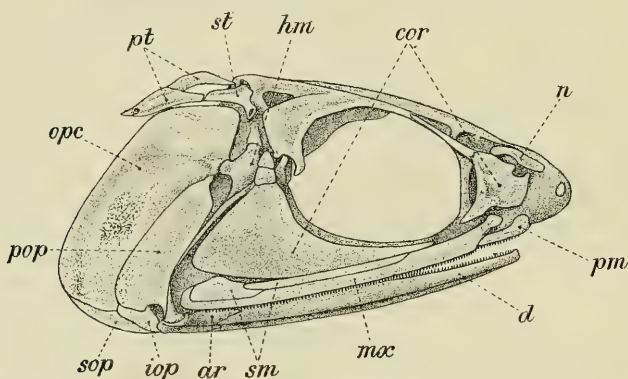
The lateral temporal groove is broad and shallow. Removal of its floor exposes a fairly large cavity opening laterally by two apertures—one over the articular process of the squamosal for the reception of the posterior head of the hyomandibular, and the other immediately in front of this. The cavity is roofed by the frontal, and is bounded in front by the postfrontal, behind by the squamosal, and below mainly by the pro-otic.

The parasphenoid is depressed at about the middle of its length, doubtless in relation with the large size of the eyes. It does not project behind the occipital articulation, but it ends posteriorly in a pair of parallel lamellæ on the right and left sides of the posterior outlet of the eye-muscle canal. Both parasphenoid and vomer are edentulous. The front of the cranium is formed by the mesethmoid, and not by the vomer (cf. *Clupea*). The mesethmoid is large, of considerable vertical extent, but thin; the prefrontals are relatively small. The orbitosphenoid is small, and

makes no attempt to support the great membranous interorbital septum, neither does it send a process forward to meet the prefrontals as it does in *Clupea*.

Temporal and Preopercular Series (text-fig. 134).—The post-temporal has the usual three limbs. The longest is the upper limb, loosely attached by ligament to the upper surface of the epiotic. The opisthotic limb is delicate and rod-like, and is attached, as already mentioned, to a process of the exoccipital, there being no distinct opisthotic bone. The horizontal limb, bearing the sensory canal, touches the back of the supratemporal. The supratemporal has the usual triradiate form. The axis of the preopercular slopes downward and backward, and its lower limb is very short, and instead of being forwardly directed is vertical. The interopercular is remarkably small.

Text-fig. 134.



Engraulis encrasicolus, right side of skull. For explanation of lettering see p. 493.

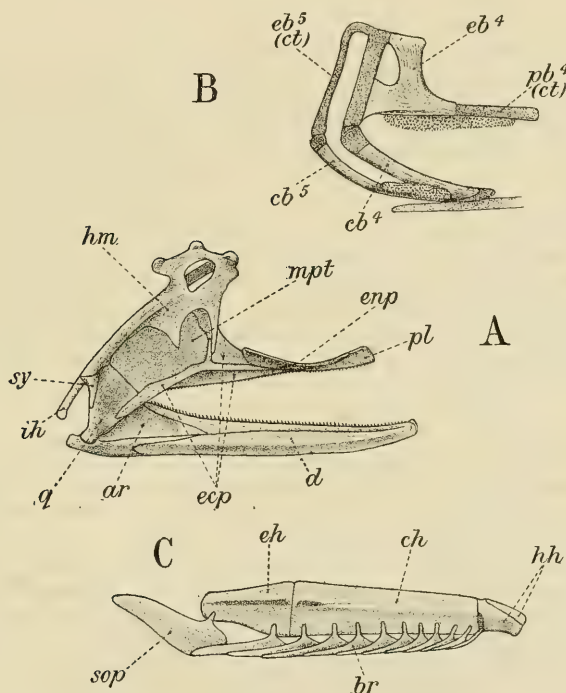
Circumorbital Series (text-fig. 134).—The bones of this series are six in number. The largest lies below and behind the eye, and above this bone are two small postorbitals. Both nasal and preorbital, particularly the latter, are relatively larger than in *Clupea*.

Maxillary Series (text-fig. 134).—The premaxilla is small, and bears teeth on the posterior half of its lower edge. The two premaxillæ extend, without meeting, below the mesethmoid, and not in front of it as in *Clupea*; it is, in fact, the projection of the ethmoid region in advance of the mouth that gives the characteristic appearance to the head of *Engraulis*. The maxilla is long, and is toothed all along its edge except at the anterior end, where it is overlapped by the premaxilla. There are two surmaxillæ, a broad one behind and a long thin one in front. They lie in an extensible membrane which is continuous with the lower edge of

the suborbital plate, and they form a triangle with the posterior half of the maxilla when the mouth is widely opened.

Mandibular Series (text-figs. 134 and 135 A).—The mandible is long, and the dentary bears teeth along the whole of its upper edge. The coronoid process is situated far back, and does not rise high in proportion to the length of the ramus. The angular is not distinct from the articular, and there is no sesamoid articular.

Text-fig. 135.



Engraulis encrasicolus.—A, hyopalatine arch and mandible of left side, mesial aspect; B, fourth and fifth branchial arches of left side, mesial aspect; C, hyoid of right side, with branchiostegal rays and subopercular bone, external view. For explanation of lettering see p. 493.

Hyopalatine Series (text-fig. 135 A).—The most striking features of the hyopalatine arch are related to the backward thrust of the quadrate articulation. The axis of the quadrate slopes backward; the axis of the hyomandibular also slopes backward, but the symplectic is not in the same line with it, as might have been expected. The hyomandibular articulates with the cranium by two distinct heads, and the opercular head is fairly long. The edges of the palatine and ectopterygoid bear microscopic teeth,

and a row of similar teeth occurs on the middle of the palatal surface of the entopterygoid.

Opercular Series (text-figs. 134 and 135 C, pp. 474, 475).—The opercular bone is remarkably large; the subopercular is comparatively small, and extends forward beneath the interopercular, and is bound to the posterior part of the outer face of the epihyal in such a way that it has a tendency, during the process of disarticulation of the skull prior to the maceration of the parts, to leave the opercular bone and to come away with the hyobranchial skeleton. In such cases it is liable to be mistaken for the hindmost of the branchiostegal rays (text-fig. 135 C, p. 475), a fact long ago noted by Valenciennes, who wrote (*Hist. Nat. Poiss.* xxi. 1848, p. 11) concerning the subopercular, “il faut faire attention de ne pas le confondre avec un rayon de la membrane branchio-stège.” This is an argument in favour of regarding the opercular, subopercular, and branchiostegal bones as components of one and the same series, to which series the preopercular and interopercular do not belong.

The branchiostegal rays are usually ten in number on each side, sometimes nine or eleven; I have not seen as many as thirteen, the number given by Valenciennes (*l. c.* p. 11) and Günther (*Brit. Mus. Cat. Fishes*, vii. p. 386). The first nine are situated on the outer face of the whole length of the ceratohyal, the last on the epihyal. They form a well-graduated series, and are flat, not rod-like. When, as above mentioned, the subopercular is left attached to the epihyal, it is seen that the subopercular and the last branchiostegal ray resemble one another closely in shape and size, but that there is some discontinuity in the series owing to the interval between the subopercular and the last branchiostegal ray being greater than that between the last two branchiostegal rays (text-fig. 135 C, p. 475).

Hyobranchial Series.—The interhyal is a long and rod-like bone (text-fig. 135 A, p. 475). The hyoid is long, the posterior end of the epihyal being close to the posterior end of the first ceratobranchial. The lower hypohyal is much larger than the upper, and excludes the latter from union with the ceratohyal (text-fig. 135 C, p. 475). The glossohyal is extremely reduced, and consists of a small cone of cartilage, with a small cap of edentulous membrane-bone on its upper surface. The urohyal is long and slender.

A narrow membrane-bone, with crowded small teeth, extends over the whole length of the second basibranchial, and projects forwards over the posterior half or more of the first basibranchial and backwards over the anterior sixth of the third basibranchial. The second basibranchial is remarkably long, a fact which disturbs the parallelism of the first and second ceratobranchials. The first hypobranchials are long, almost as long as the first ceratobranchials; the second, however, are small and triangular, and are fused with the sides of the posterior end of the second basibranchial. The third hypobranchials are normal, and slope obliquely down the sides of the third basibranchial.

The epipharyngeal teeth and the hypopharyngeal teeth on the fifth ceratobranchials are larger and more pointed than the teeth of the basibranchial skeleton. A slender cartilaginous fifth epibranchial is present, confluent at its upper end with the cartilaginous posterior part of the fourth epibranchial (text-fig. 135 B, p. 475). Between the cartilaginous and ossified parts of the fourth epibranchial is a fenestra closed by membrane. The first pharyngobranchial is cartilaginous and small; the spicular bone is remarkably long and slender.

COILIA NASUS.

Material examined.—In addition to a skull specially prepared for the purposes of this investigation from an alcohol-preserved specimen from Kiu Kiang kindly furnished by Mr. G. A. Boulenger, another skull was examined, belonging to a complete skeleton in the Osteological Collection of the British Museum (Brit. Mus. 91.1.31.30, Shanghai).

Cranium (text-fig. 136, p. 478).—The cranium is broad and short, and its posterior surface, instead of rising vertically from the basioccipital, slopes very much forward. The parietal bones nearly meet in front of the supraoccipital. The posterior temporal groove is shallow, and has neither a pre-epiotic fossa nor a temporal foramen, although on the course of the suture between the frontal and the parietal bones is a minute depression, large enough to admit the point of a pin, which evidently represents the last trace of the closed foramen. There is no auditory fenestra between the pro-otic, exoccipital, and basioccipital bones.

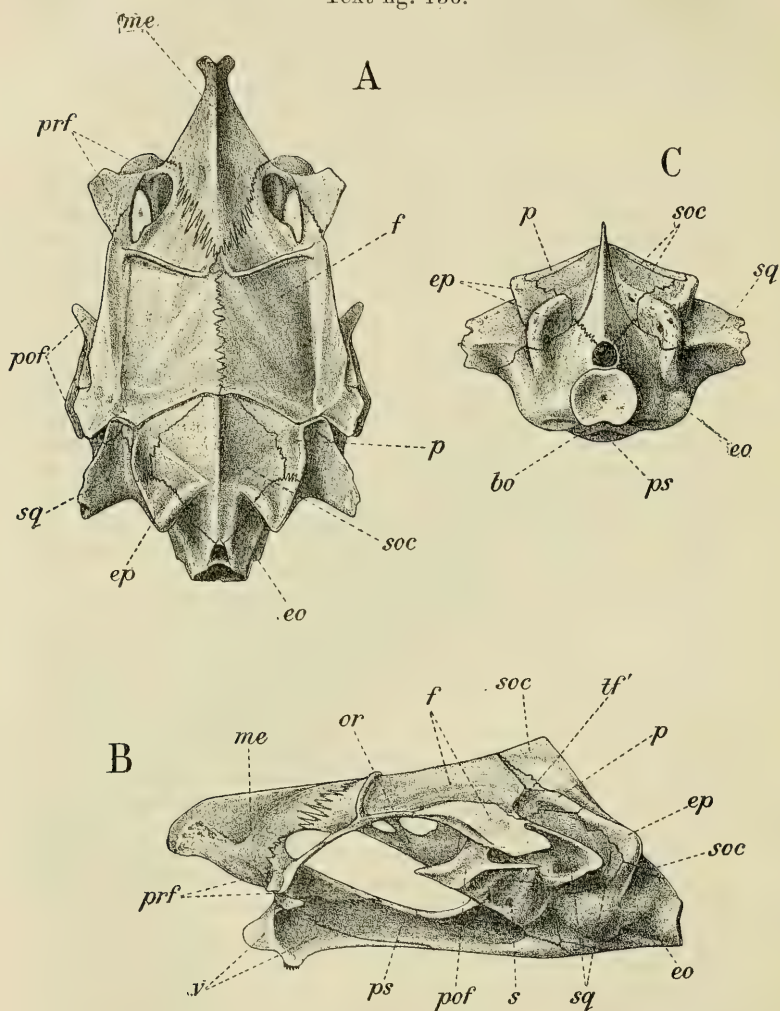
The bony bullæ containing the cæcal diverticula of the swim-bladder are large and prominent. The pro-otic one occupies nearly the whole of the ventro-lateral face of the pro-otic bone, and its upper extremity projects upwards into a lateral vacuity of doubtful homology, but evidently corresponding with that cavity which in *Engraulis* lies beneath the lateral temporal groove, bounded above by the frontal and squamosal, below by the post-frontal, pro-otic, and squamosal, behind by the squamosal, and in front by the postfrontal. The squamosal bulla is just visible in the hinder part of this vacuity, and also above it, in the floor of the posterior temporal groove. It is freely open below into a large exoccipital bulla*, the equivalent of the fusiform dilatation of the air-duct which in *Clupea* leads to the pro-otic and squamosal vesicles. Behind this, however, is another smaller exoccipital bulla which is blind posteriorly, and communicates anteriorly by a narrow neck with the former exoccipital vesicle.

The squamosal bone takes no part in the articulation for the head of the hyomandibular; this is formed mainly by the post-frontal, but partly also by the pro-otic. The appearances are such as strongly to suggest that the posterior head of the hyo-

* These relations can only be made out by making suitable incision into the cranial bones.

mandibular of *Engraulis* and its corresponding articular facet in the squamosal bone have disappeared in the present genus. In text-fig. 138 (p. 481) the part marked *hm'* is the articular head

Text-fig. 136.



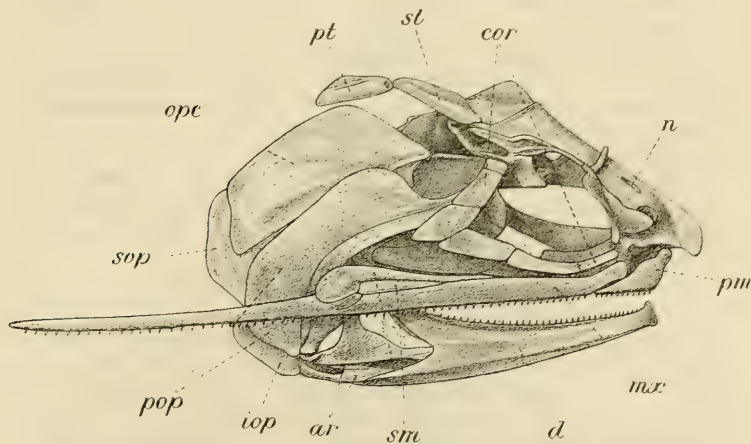
Cranium of *Coilia nasus*.—A, dorsal view; B, left side; C, back view. *s*, point of attachment of the spicular bone to the pro-otic; *tf'*, last trace of temporal foramen. For explanation of other lettering see p. 493.

of the hyomandibular, the part above and behind the fenestra is comparatively remote from the side of the cranium.

The parasphenoid has no ascending processes in the region of the pro-otics, but there is a well-marked process of each pro-otic, directed forward and downward, which is suturally united with the supero-lateral edge of the parasphenoid. The parasphenoid is short, and underlies but a small portion of the basioccipital. It has no posterior wings, and the eye-muscle canal does not open behind, although there is a minute depression at the back of the parasphenoid, in the region where the opening might be expected to occur. The anterior part of the parasphenoid is broad, V-shaped in section, and united by elaborate jagged sutures with the prefrontals and vomer. The vomer has five or six teeth on each side, the two patches being widely separated. The mesethmoid projects considerably in advance of the vomer and has a dorsal crest; yet the ethmoid region as a whole is short.

Running across the roof of each frontal is an arched bar of bone. The alisphenoids face forwards, *i. e.* they lie transversely to the cranial axis instead of sloping forward and inward. The orbitosphenoid is fairly large, and is tubular in its hinder two-thirds. It passes back between and below the alisphenoids, and comes into extensive relation with the pro-otic bones. The tubular part does not lie close up under the median suture of the frontals, but is separated by a vertical fenestrated sheet of the orbitosphenoid bone. The opisthotic is absent, and there seems to be no basisphenoid.

Text-fig. 137.



Coilia nasus, right side of skull. For explanation of lettering see p. 493.

Temporal and Preopercular Series (text-fig. 137).—The post-temporal has but one limb, a long one, the anterior extremity of which rests on the epiotic prominence. This limb is concealed in text-fig. 137 by the supratemporal. The rest of the bone

consists merely of a semi-tubular scale touching the back of the supratemporal. The supratemporal is a tubular scale which does not exhibit the usual triradiate character, since the parietal division of the sensory canal branches in the skin just anterior to the supratemporal bone. The axis of the preopercular slopes strongly backward; the anterior edge of the bone is concave and not angulate, so that the proportions of the upper and lower limbs cannot be determined.

Circumorbital Series (text-fig. 137, p. 479).—The nasal is very small. Beneath the nasal sac are two bones, both rather firmly attached to the prefrontal. There are three postorbitals and three suborbitals, the former series making an acute angle with the latter.

Maxillary Series (text-fig. 137, p. 479).—The extraordinary length of the maxilla is one of the most remarkable features of the fish under consideration; indeed, it is difficult to understand what purpose the teeth on the hinder part of the maxilla can possibly serve. A similar prolongation of the maxilla is met with in some species of *Engraulis*, attaining a maximum in *Engraulis mystax* and *Engraulis setirostris* (Cuvier and Valenciennes, Hist. Nat. Poiss. xxi. 1848). The actual length of the projecting part of the maxilla varies in different specimens of *Coilia*, doubtless owing to fracture during life; but it may be taken as a rule that the toothed part of the maxilla is two-and-a-half times as long as the tooth-bearing part of the dentary. The premaxillæ extend below the mesethmoid, not in front of it; they nearly touch, but do not actually meet in a symphysis. There are two surmaxillæ.

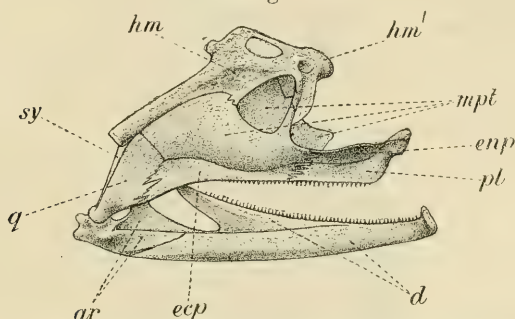
Mandibular Series (text-figs. 137 and 138, pp. 479, 481).—The mouth is so large that the ramus of the mandible is longer than the cranium. The dentary and articular components of the coronoid process are separated by a short interval. This separation, however, although striking, is evidently a feature of no great importance; it occurs in an exaggerated form in *Gonorrhynchus*, it occurs in some Percoid and Berycoid fishes, and doubtless in many other groups. The dentary bears teeth similar to those on the maxilla and premaxilla. The angular is not distinct from the articular, and there is no sesamoid articular.

Hyopalatine Series (text-fig. 138, p. 481).—In relation with the great size of the mouth the quadrate articulation is thrown far back, and both quadrate and hyomandibular bones are backwardly rotated. The head by which the hyomandibular articulates with the cranium is small and single (see p. 478). The symplectic is not in a direct line with the axis of the hyomandibular, but forms an angle of about 140 degrees with it. The metapterygoid is large, and the entopterygoid small. The ectopterygoid is nearly straight, and the palatine articulates with the prefrontal by two contiguous heads, which are right and left, not anterior and posterior. Teeth are borne on the edge of the palatine and the anterior part of the edge of the ectopterygoid.

Opercular Series (text-fig. 137, p. 479).—The opercular bone has a

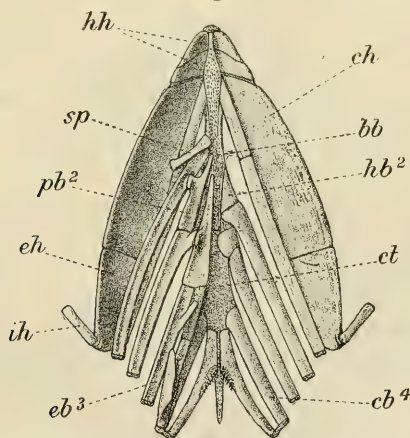
strongly marked backward slope; the opercular and subopercular bones are of average size, and take no share in that enlargement which is so marked in the bones of the mouth. There are eleven branchiostegal rays on each side. The first is attached at the front of the ceratohyal, the ninth at the junction of the ceratohyal and epihyal, and the remaining two on the epihyal. They are all curved rods except the last two, which are somewhat lamellate.

Text-fig. 138.



Coilia nasus, hyopalatine arch and mandible of left side, mesial aspect: *hm'*, head of hyomandibular articulation with the cranium. For explanation of other lettering see p. 493.

Text-fig. 139.



Coilia nasus, hyobranchial skeleton, dorsal view. The epibranchials and pharyngo-branchials of the right side are not shown. For explanation of lettering see p. 493.

Hyobranchial Series (text-fig. 139).—The interhyal is a long, rod-like bone. There are two hypohyals, the upper one small and situated antero-superiorly to the lower, which alone is in Proc. Zool. Soc.—1904, Vol. II. No. XXXI. 31

contact with the front of the ceratohyal. The glossohyal is an ill-defined cartilage of small size. The second basibranchial is large in comparison with the first and third, but it is a hollow shell of bone, the interior of which is occupied by a fatty mass. The dentigerous membrane-bone that covers it overlaps the posterior three-fourths of the first basibranchial and the anterior third of the third basibranchial.

The second hypobranchials are fused with the sides of the second basibranchial, but the line of demarcation is obvious. The third hypobranchials are rather long, and slope forward and downward at the sides of the third basibranchial. The urohyal is long, and extends considerably behind the posterior end of the third basibranchial. The epibranchials are longer than usual in proportion to the ceratobranchials; the fourth is moderately expanded in a vertical direction.

The first pharyngobranchial is cartilaginous; and the spicular bone projects upward, backward, and outward, and is attached to the pro-otic bone at the point marked *s* in text-fig. 136 B, p. 478. The cartilaginous plate that represents the fourth and fifth basibranchials is continued back between the closely approximated anterior ends of the fifth ceratobranchials, and projects some distance behind as a free rod of cartilage.

CHANOS SALMONEUS.

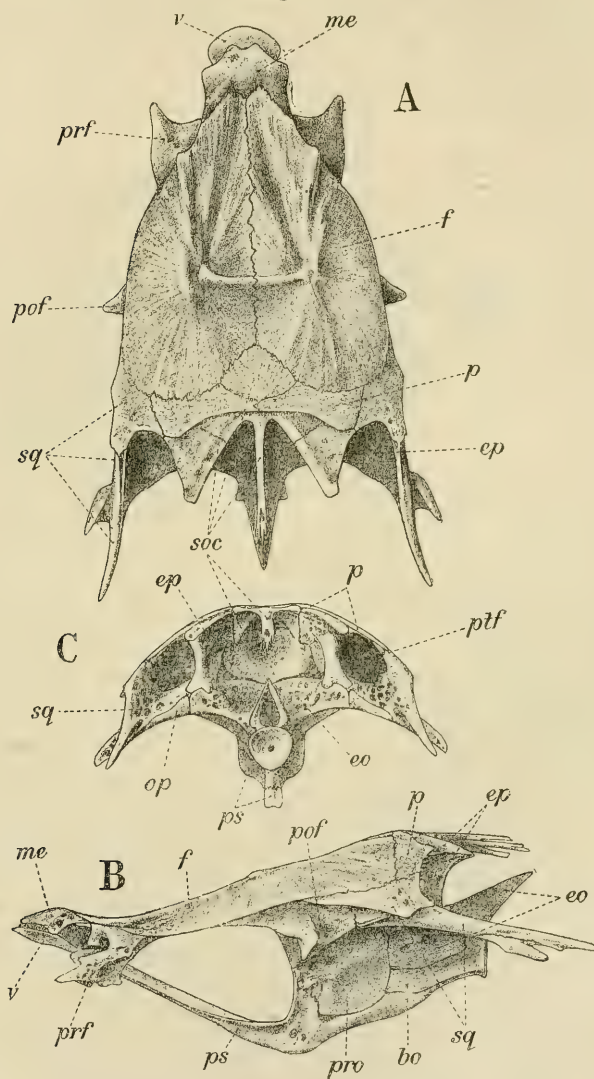
The accessory branchial organ of *Chanos*, briefly alluded to by Johannes Müller ('*Bau und Grenzen der Ganoiden*,' Berlin, 1846, pp. 74 and 75), has been described and figured by Hyrtl, but the relations of the skeletal parts to this organ are not shown (Denkschr. Akad. Wiss. Wien, xxi. 1863, pp. 1-10 and pl. 1; also Sitzungsber. Ak. Wiss. Wien, xliii. 1, 1861, pp. 155 & 156).

Material examined.—In addition to two skulls (a large one, A, and a small one, B) specially prepared for the purposes of this investigation from alcohol-preserved specimens kindly furnished by Mr. G. A. Boulenger, a third skull (C) was examined, belonging to a skeleton in the Osteological Collection of the British Museum (Brit. Mus. 98.9.13.1, Tongatabu).

Cranium (text-fig. 140, p. 483).—The cranium is broad and flattened. The parietals are separated by the supraoccipital, but above the supraoccipital there lie two sensory-canal scales of the transverse commissural system which in old specimens (A and C) fuse with the right and left parietals, and thus produce the effect of a false union of the two parietals over the supraoccipital (text-fig. 140 A, p. 483). The posterior temporal fossa is large and completely roofed in. Its inner wall is formed by the supraoccipital and epiotic, its floor and outer wall by the postfrontal and squamosal, and its roof by the frontal, parietal, squamosal, and epiotic. Its anterior end is blind, and lies over the middle part of the postfrontal bone. Hyrtl (*l. c.* p. 3) has pointed out that the great posterior temporal

vacuity is occupied by the upper longitudinal trunk-muscle, and contains nothing else.

Text-fig. 140.



Cranium of *Chanos salmoneus*.—A, dorsal view; B, left side; C, back view.
 For explanation of lettering see p. 493.

Owing to the considerable extent to which the epiotic bones project posteriorly, and to the hollowness of the posterior surface

of the supraoccipital, there is a large depression at the back of the cranium between the two epiotics. This is not subdivided by a median crest of the supraoccipital, but a supraoccipital spine lies dorsally to it, and splits up posteriorly into seven or eight fine bony filaments, compared by Hyrtl (*l. c.* p. 3) with the ossified tendons of birds. The two exoccipitals are produced backward and upward into pointed plates, which form a roof not only for the medulla oblongata, but for the anterior part of the spinal cord as well.

The squamosal is produced into a spine which slopes backward, outward, and downward, and extends to the posterior end of the post-temporal. The opisthotic is small, and is applied to the inner side of the basal portion of this spine, but it also touches the exoccipital. The articular surface for the head of the hyomandibular slopes downward and forward. The lateral temporal groove above the postfrontal spine is to a large extent roofed over by projecting eaves from the frontal and squamosal bones, mainly the former. Incision into the squamosal and pro-totic bones fails to disclose the presence of bullæ for the lodgment of cæcal diverticula of the swim-bladder. There is no subtemporal fossa.

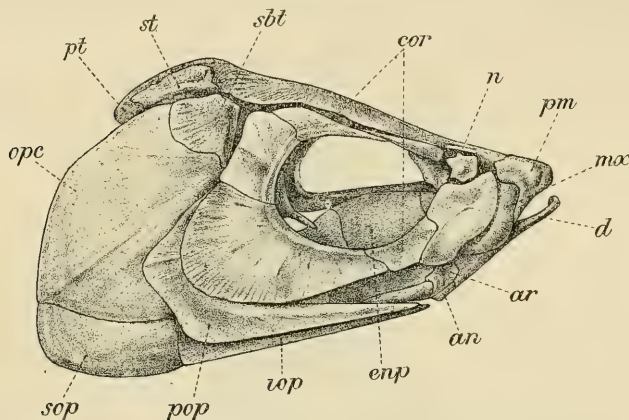
There is no orbitosphenoid nor basisphenoid. The parasphenoid is rather sharply bent at about the middle of its length, and at this point there is on the ventral surface a well-marked oval depression. The ascending wings of the parasphenoid rise moderately high up the front of the pro-totics. The parasphenoid does not extend as far posteriorly as the hind end of the basioccipital, and the eye-muscle canal does not open behind. Neither the parasphenoid nor the vomer bears teeth. A considerable proportion of the ethmoid region remains cartilaginous. The prefrontals do not meet one another mesially, and the mesethmoid is a thin horizontally disposed lamina of bone of ectosteal origin.

Projecting backward and outward from each side of the back of the cranium are two strong tendon-bones, or intermuscular bones. The larger of the two arises from the dorso-latero-posterior part of the basioccipital, and is attached to the upper end of the clavicle. The other arises from the back of the exoccipital, immediately posterior to the aperture for the exit of the vagus nerve, and terminates in muscular tissue. The deep limb of the post-temporal, attached to the opisthotic, is parallel to these, and its resemblance to them is very striking.

Temporal and Preopercular Series (text-fig. 141, p. 485).—The post-temporal tends to fuse with the supraclavicular. Its upper limb is long, and lies so far over the epiotic as to touch the supraoccipital. The deep limb is about half as long as the former and is attached to the opisthotic. A study of the skull of *Chanos* leaves little room for doubting that the opisthotic limb of the post-temporal belonged primarily to the same category as the tendon-bones that project back from the exoccipital, but has now become united by its posterior end with the post-temporal bone (see preceding paragraph).

The third limb of the post-temporal is wanting, since the supratemporal overlaps the body of the post-temporal. The supratemporal is a flat scale of bone, with the usual triradiate sensory canal near its lower edge. It covers in the space between the epiotic limb of the post-temporal above and the squamosal spine below.

Text-fig. 141.



Chanos salmoneus, right side of skull. For explanation of lettering see p. 493.

Overlapping the antero-superior part of the opercular bone is a flat bone which may be termed the "subtemporal." A branch of the sensory canal passes from the supratemporal down the anterior edge of the bone on its way to the preopercular, which fact, taken in conjunction with the position of the bone below the squamosal and above the preopercular, points to the conclusion that the bone is the homologue of that which, in the Salmon, Parker (Phil. Trans. Roy. Soc. clxiii. 1873, p. 99 and pl. 6. fig. 1, *st*) erroneously called the supratemporal.

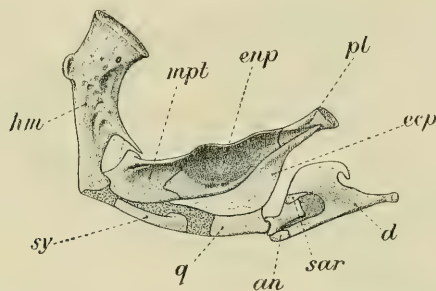
In relation with the forward displacement of the quadrate articulation, the interopercular and the lower limb of the preopercular are much elongated in a horizontal direction.

Circumorbital Series (text-fig. 141).—There are eight bones of this series. The orbital ring is complete, there being two elongated supraorbitals which meet above the eye. The anterior of the two is in the large specimens examined (A and C) swollen after the manner of the frontal and some other bones of *Ephippus*. The nasal is remarkably small and liable to be overlooked.

Maxillary Series (text-fig. 141).—The premaxilla and maxilla are short and broad, the gape being greatly reduced in size. Except when the mouth is opened to an unnaturally wide extent, the premaxilla alone bounds the gape above. Both the premaxilla and maxilla are thin, curved scales with sharp lower edges, devoid of teeth. There is no surmaxilla.

Mandibular Series (text-figs. 141 and 142).—The mandible is of remarkable shape, since the anterior part is quite thin, having the form of a curved rod, whereas the coronoid process is broad and stands high. The coronoid process is formed entirely by the dentary, there being no ascending process of the articular. A sesamoid articular is present; it lies above the anterior part of the endosteal articular, and is slightly movable in a wet preparation. The angular is distinct from the articular. There are no teeth.

Text-fig. 142.



Chanos salmonus, hyopalatine arch and mandible of left side, mesial aspect.
For explanation of lettering see p. 493.

Hyopalatine Series (text-fig. 142).—The hyomandibular articulates with the cranium by a single broad head, the upper edge of which, instead of being horizontal, slopes downward and forward. In relation with the reduction in the size of the mouth, the quadrate has been drawn so far forward as to have parted from the symplectic and metapterygoid entirely, and it is attached to the ectopterygoid in such a way that a fair proportion of this bone lies behind it. The hyomandibular appears to be but little affected, and its axis is nearly vertical. There is an angle of about 110 degrees between the axes of the symplectic and hyomandibular. No teeth occur on the palatine and pterygoid bones.

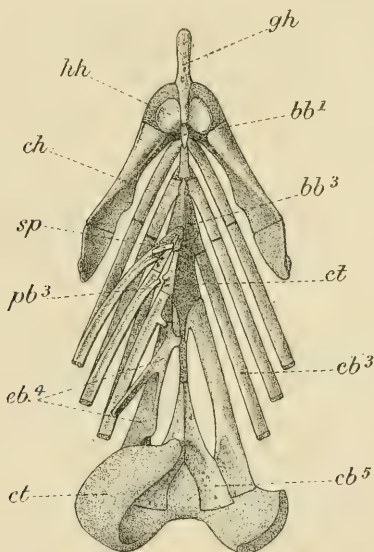
Opercular Series (text-fig. 141, p. 485).—The opercular and subopercular bones are of average proportions; the ascending process of the subopercular which rises along the front edge of the opercular is high and slender. There are only four branchiostegal rays on each side. They are long, and rather broad and lamellate. Two are attached to the outer face of the posterior part of the ceratohyal, and two on the outer face of the epihyal. On examining the skull of *Chanos*, one cannot fail to be impressed by the regular manner in which the branchiostegal rays grade off into the opercular and subopercular bones, whereas the preopercular and interopercular fail to fit into the series.

Hyobranchial Series (text-fig. 143, p. 487).—The most striking features of the hyobranchial skeleton are the smallness of the hyoid,

the great size of the urohyal, and the enlargement of the hinder parts for the support of the wall of the epibranchial organ. The structure of this organ has been described by Hyrtl (*l. c.* p. 4).

The lower hypohyal is considerably larger than the upper. The hind end of the glossohyal overlaps the front of the first basibranchial, and a thin flake of bone projects from the back of the first basibranchial over the front of the second. A similar

Text-fig. 143.



Chanos salmoneus, hyobranchial skeleton, dorsal view. The epibranchials and pharyngobranchials of the right side are not shown. For explanation of lettering see p. 493.

flake extends from the second basibranchial over the front part of the third. The anterior half of the glossohyal is cartilaginous, but is covered by a membrane-bone which is continued back over the endosteal glossohyal. The third basibranchial is larger than the first and second put together—as a rule the second basibranchial is the largest of the three. The third hypobranchials are fused with the sides of the third basibranchial, but the boundary line between them is not obliterated.

There is a symphysis of considerable length between the two fifth ceratobranchials, and from the front of this symphysis there passes forward a bar of cartilage which, in front of the anterior ends of the fourth ceratobranchials, enlarges into a roughly hexagonal plate. The separation of the anterior ends of the fourth and fifth ceratobranchials is noteworthy. Behind the symphysis of the fifth ceratobranchials is a horizontal tract of cartilage,

continuous with the pair of great cartilages which curve upward from the suturally united posterior ends of the fourth and fifth ceratobranchials. The upper ends of these great cartilages meet in the middle line above, but do not fuse; from the anterior edge of each there stretches forward an extensive tract of thin, but tough membrane, which fills in the angle between the body of the fourth epibranchial and the remarkably long process of the same which slopes upward and backward from near its anterior end.

The first three epibranchials are of approximately the same length, but the fourth is longer and wider. The first pharyngo-branchial is a forwardly directed cartilage of conical shape, and there is an upright spicular bone rising from the junction of this with the front of the first epibranchial. There are no teeth on any part of the hyobranchial skeleton.

SUMMARY.

On comparing the foregoing accounts of the cranial osteology of *Chirocentrus*, *Clupea*, *Pellona*, *Pellonula*, *Pristigaster*, *Hyperlophus*, *Chatoëssus*, *Dussumieria*, *Engraulis*, *Coilia*, and *Chanos*, the most important features of resemblance and difference appear to be as follows.

The parietal bones are rather small in size*, and are separated the one from the other by the supraoccipital. In *Coilia*, however, they nearly meet in front of the supraoccipital, and in *Chanos*, owing to the fusion of the commissural sensory-canal bones with the parietal bones, the latter appear to meet over the top of the supraoccipital†. There is a fontanelle between the anterior ends of the two frontal bones in *Chirocentrus*, *Clupea*, *Pellonula*, *Pellona* (a mere cleft in this genus), and *Chatoëssus*, but not in the other six genera. In *Coilia* and *Engraulis* the mesethmoid projects considerably in advance of the vomer, which is not the case in the other genera.

Of the genera under consideration, the only one in which the posterior temporal groove is roofed over is *Chanos*. The temporal foramen appears to be a special feature of the Clupeoid skull. It is an aperture, usually oval in shape, with the long axis horizontal, bounded by the frontal and parietal bones. In no instance have I found the postfrontal bone forming part of the boundary, although Boulenger regards this as the normal condition‡. The only departure from the general rule that has come within my knowledge is in the case of *Engraulis*, in which a small portion of the squamosal may come between the parietal and the frontal in the

* Small is, of course, but a relative term, and opinions may differ as to the employment of the word. "Très petits," the expression used by Boulenger (Poissons du Bassin du Congo, 1901, p. 123), appears to me to convey an exaggerated idea of the smallness of the parietal bones. I leave the figures that illustrate this paper to speak for themselves.

† Cope, it is worth noting, included the Lutodiridæ (*i. e.* Chanidæ) under the heading "Parietals united" (Trans. Amer. Phil. Soc. n. s. xiv. 1871, p. 455).

‡ Poiss. Bass. Congo, 1901, p. 123. "Un grand trou de chaque côté du crâne bordé par le frontal, le postfrontal, et le pariétal."

lower edge of the foramen, but does not invariably do so. The temporal foramen is reduced to a pin-point depression in *Coilia*, and is wanting entirely in *Chanos*.

The pre-epiotic fossa, another Clupeoid feature, is a depression at the side of the cranium, bounded by the epiotic, squamosal, and parietal bones. It is wanting in *Chanos*; in *Coilia* it is entirely obliterated, and in *Pristigaster* and *Hyperlophus* largely filled up by the prominent squamosal bulla. The pre-epiotic fossa is probably homologous with the "lateral cranial foramen" of the Mormyroid fishes and *Notopterus*. The supratemporal bone lies over the aperture of the fossa in the Clupeoid fishes, but being a reduced bone it serves less obviously as a cover for the fossa than does the supratemporal for the foramen in the Mormyridæ. In *Notopterus* the supratemporal bone is reduced in size quite as much as in the majority of the fishes now under consideration, and more so than in *Dussumieria*. The pre-epiotic fossa is bounded by the parietal, epiotic, and squamosal, whereas the foramen of *Notopterus* and the Mormyridæ is set a little lower down, and is surrounded by the epiotic, squamosal, and exoccipital, the parietal in these fishes occupying a position nearer the median plane of the head, and being shut off from the foramen by the union of the squamosal with the epiotic. The suggestion is strengthened by the fact that in *Dussumieria* the bottom of the fossa is unossified and membranous. If in the preparation of the skull the membrane be removed, the fossa appears as a large foramen leading into the cranial cavity.

The lateral temporal groove, situated above and behind the postfrontal bone, is not well marked in the Clupeoid fishes, with the exception of *Chanos*; in most cases it is broad and shallow, and is barely recognisable as a groove. There is no subtemporal fossa. The opisthotic bone is as a rule present, but small; it is wanting in *Engraulis* and *Coilia*.

The bullæ in the pro-otic and squamosal bones for the lodgment of caecal diverticula of the swim-bladder are remarkably constant. Both, however, are wanting in *Chanos*, and the squamosal bulla is not present in *Clupea sprattus*, although it occurs in the other species of *Clupea* examined. The auditory fenestra, bounded by the pro-otic, exoccipital, and basioccipital bones, is also a distinctive feature of the Clupeoids, although it occurs also in *Hyodon*, in which it is bounded by the same three bones. It is wanting in *Chanos* and *Coilia*. The orbitosphenoid and basisphenoid bones are variable in size; both are wanting in *Chanos*. In *Clupea*, *Hyperlophus*, *Chatoëssus*, and *Dussumieria* the orbitosphenoid meets the prefrontal bones.

The eye-muscle canal opens behind in all but *Chanos* and *Coilia*, and except in these two genera and *Chatoëssus* the parasphenoid is produced into a pair of posteriorly directed vertical laminae of bone. In *Chatoëssus* the vertical laminae are present at the sides of the posterior opening of the eye-muscle canal, but they are not produced backward into freely projecting wings.

Not one of the eleven genera under consideration has parasphenoidal teeth, and only *Coilia*, *Dussumieria*, *Clupea harengus*, and *Clupea sprattus* have teeth on the vomer.

The post-temporal bone has an epiotic limb in all, and a deep or opisthotic limb in all but *Coilia*. In *Chatoëssus* the union between the post-temporal bone and the epiotic is more of the nature of a synovial articulation than a ligamentous connection. The supratemporal bone is of the same character in all, and in all but *Coilia* the sensory canal that it carries is triradiate. A subtemporal or supraopercular bone is present in *Chanos*.

The nasal bone is small and loosely embedded in the skin, and there are from five to eight bones disposed around the eye. In *Chatoëssus* and *Chanos* the premaxilla bounds the upper border of the mouth; in the other nine genera the gape is bounded above by both premaxilla and maxilla, although in *Pristigaster* and *Hyperlophus* the maxilla takes but a small share. In *Chirocentrus*, *Clupea*, *Pellona*, *Pristigaster*, *Dussumieria*, *Engraulis*, and *Coilia* both maxilla and premaxilla bear teeth, although in *Pellona* the teeth are vestigial: in *Pellonula* the premaxilla bears teeth, but not the maxilla; in *Chanos*, *Chatoëssus*, and *Hyperlophus* both premaxilla and maxilla are edentulous. The premaxilla is firmly united to the maxilla by fibrous tissue in *Chirocentrus*. Two surmaxillæ are present on each side of the head in all but *Hyperlophus*, *Chatoëssus*, and *Chanos*; *Hyperlophus* and *Chatoëssus* have one, and *Chanos* none.

The angular is a distinct bone in all but *Engraulis* and *Coilia*. The endosteal part of the articular can be recognised, but in no case is it separate from the ectosteal part. A small sesamoid articular is found in *Chirocentrus*, *Clupea finta*, and *Chanos*.

The hyomandibular articulates with the cranium by two heads in *Clupea finta*, *Hyperlophus*, *Chatoëssus*, *Dussumieria*, and *Engraulis*, and by a single head in *Chirocentrus*, *Clupea harengus*, *Pellona*, *Coilia*, and *Chanos*. In *Coilia* the single head present is probably equivalent to the anterior of the two heads found in *Engraulis*. In *Chanos* alone of the genera under consideration is the quadrate separated from the symplectic and metapterygoid. Teeth are borne by the palatine bone in *Chirocentrus* (4 or 5 minute teeth), *Clupea sprattus* (a row of teeth), *Clupea harengus* (2 or 3 minute teeth), *Pellona*, *Pellonula*, *Pristigaster*, *Dussumieria*, *Engraulis*, and *Coilia*; the palatine is edentulous in *Chanos*, *Chatoëssus*, *Hyperlophus*, and *Clupea finta*. The ectopterygoid is toothed in *Pellona*, *Dussumieria*, *Engraulis*, and *Coilia*, but not in *Chirocentrus*, *Clupea*, *Pellonula*, *Pristigaster*, *Hyperlophus*, *Chatoëssus*, and *Chanos*; the entopterygoid is toothed in *Clupea sprattus* (a few teeth), *Pellona*, *Pellonula*, *Pristigaster*, *Dussumieria*, and *Engraulis*, but not in the other forms examined.

The branchiostegal rays are most numerous in *Dussumieria* (13), *Engraulis* (11), *Coilia* (11), and are fewest in *Chanos* (4). *Chirocentrus* has 8, *Clupea* 7 or 8, *Chatoëssus* 6, *Hyperlophus* 5. The interhyal is bony in all, except, perhaps, in *Chanos*. In all

of the forms studied there are two hypohyals on each side, and the lower of the two is larger than the upper. The first pharyngo-branchial is ossified in *Chirocentrus*, but remains cartilaginous in the other genera; the ossified ligament known as the spicular bone is present in all except *Chirocentrus*. In *Engraulis* and *Coilia* the second hypobranchials are fused with the sides of the second basibranchial, and in *Chanos* the third hypobranchials are fused with the sides of the third basibranchial, but in none of the three cases are the sutures obliterated.

COMMENTS ON THE SKULL OF THE CLUPEOID FISHES.

Of the eleven genera the skulls of which have been described in the previous pages the greatest interest centres around *Chanos* and *Chirocentrus*. As regards the others, the craniological characters are such as would justify the placing of *Engraulis* and *Coilia* in one family, the Engraulidæ, and *Clupea*, *Pellona*, *Pellonula*, *Pristigaster*, *Hyperlophus*, *Chatoëssus*, and *Dussumieria* in another, the Clupeidæ.

Both *Engraulis* and *Coilia* have a large gape, a backwardly thrust quadrate bone, and a large and prominent mesethmoid. The skull of *Coilia* differs from that of *Engraulis* in several respects, but these are all of such a nature as might be explained by high specialisation; such characters, for instance, are the reduction of the temporal foramen, the obliteration of the pre-epiotic fossa, the absence of the auditory fenestra, the absence of paired posterior wings of the parasphenoid and the closure of the eye-muscle canal, the absence of the opisthotic limb of the post-temporal, and the loss of the posterior of the two heads by which the hyomandibular articulates with the cranium. The paradoxical extension of the maxilla behind the mandibular articulation is foreshadowed in some species of *Engraulis*, e. g. *E. mystax* and *E. setirostris*.

The skull of *Chatoëssus* conforms with the Clupeoid type, in spite of certain aberrant features, such as the absence of projecting wings from the back of the parasphenoid, the intimate articulation of the epiotic limb of the post-temporal with the cranium, the small size of the mouth, the bounding of the mouth above by the premaxilla alone, the absence of teeth, and the loss of one of the surmaxillæ. The characters of the skull do not warrant the separation of *Chatoëssus* from the Clupeidæ to constitute a distinct family, although possibly on other grounds the action of Gill (Smithsonian Miscell. Coll. No. 247, 1872, p. 17) and Jordan and Gilbert (Bull. U.S. Nat. Mus. No. 16, 1882, pp. 262-274) may prove to be justifiable.

Chirocentrus agrees so closely in the structure of its skull with the Clupeidæ, that appeal must be made to other organs of the body for evidence to support the views of those who would make of it a distinct family, the Chirocentridæ (e. g., Valenciennes, Hist. Nat. Poiss. xix. 1846, pp. 150-168; Kner, Reise der

Fregatte Novara, Zool. i. 1869, Fische; Cope, Trans. Amer. Phil. Soc. n. s. xiv. 1871, p. 455; Gill, *l. c.* p. 17; Smith Woodward, Brit. Mus. Cat. Foss. Fishes, iv. 1901). Their justification appears to lie mainly in the fact that *Chirocentrus* possesses in its intestine a spiral valve which is not present in *Clupea* and its allies (Valenciennes, *l. c.* p. 160 and pl. 565), in the absence of cæca (*ibid.* p. 162), and in the presence of a pseudobranch in *Chirocentrus* and its absence from most Clupeoids (Müller, Abhandl. Akad. Wiss. Berlin, 1844 (1846), p. 191). The only craniological differences worth mentioning are the considerable depth of the posterior temporal groove of *Chirocentrus*, the small size of the orbitosphenoid, the firm union between the premaxilla and maxilla (Valenciennes, *l. c.* pp. 150, 152, and 154), the more or less complete concealment of the symplectic (Boulenger, Ann. Mag. Nat. Hist. (7) xiii. 1904, p. 164), the bony nature of the first pharyngobranchial, and the absence of a spicular bone. The value of the evidence of the last two items is certainly not great, for except when (as in *Elops*) both ossified first pharyngobranchial and spicular bones are present, it is not possible to deny absolutely that what appears to be the first pharyngobranchial bone is not the spicular bone which has become shortened and thickened and more forwardly directed than usual.

The resemblances existing between the skeleton of *Chirocentrus* and that of such extinct forms as *Portheus*, *Ichthyodectes*, and *Saurodon*, which attained their maximum development in Cretaceous times, suggest that the former genus is a survival of an ancient type (see Smith Woodward, *l. c.* p. vii); but the teeth of the existing *Chirocentrus* are not lodged in distinct sockets as are those of the Saurodontidæ.

As regards *Chanos*, the evidence of the skull favours the view of separating the genus from the Clupeidæ, and of according it a family rank. *Chanos* has experienced a variety of treatment at the hands of taxonomists. It was first regarded as a species of *Mugil* (Forskål, Desc. Anim. 1775, p. 74; Gmelin, Syst. Nat. Linn. i. 3, 1788, p. 1398), and later as a species of *Leuciscus* (Gray and Richardson, Dieffenbach's 'Travels in New Zealand,' 1843, ii. p. 218). Valenciennes (Hist. Nat. Poiss. xix. 1846) placed it with *Gonorhynchus* among the "Malacoptérygiens intermédiaires entre les Brochets et les Clupes." Günther (Brit. Mus. Cat. Fishes, vii. 1868) placed it in a group "*Chanina*" of the family Clupeidæ, and Kner (Reise der Fregatte Novara, Zool. i. 1869, Fische), Cope (Trans. Amer. Phil. Soc. n. s. xiv. 1871, p. 455), and Gill (Smithson. Miscell. Coll. No. 247, 1872, p. 17) separated it from the Clupeidæ and placed it in a family of its own.

The inclusion of *Chanos* within the family Albulidæ, a step which has commended itself to so experienced an ichthyologist as Smith Woodward (Brit. Mus. Cat. Foss. Fishes, iv. pp. 60 and 64), is justified in so far as the posterior temporal fossæ are roofed over, which is not the case in any other Clupeoid fishes, and in the presence of a well-marked lateral temporal groove, partially roofed

over; also in that the bullæ in the squamosal and pro-otic bones present in other Clupeoid fishes for the lodgment of cæcal diverticula of the swim-bladder are wanting, as also are the auditory fenestra, the pre-epiotic fossa, and the temporal foramen also in the fact that the parasphenoid is not produced into a pair of posteriorly directed wings. On the other hand, such features as the reduction in the size of the mouth are as likely to be due to convergence as to genetic affinity.

The absence from the skull of *Chanos* of the orbitosphenoid and basisphenoid bones is a mark of degradation, and supports neither the hypothesis of a natural affinity between *Chanos* and the Albulidæ, nor that which would associate *Chanos* with the Clupeidæ; and the same may be said of the absence of teeth, the reduction in the number of branchiostegal rays, and the absence of surmaxillæ. The closure of the posterior outlet of the eye-muscle canal is a mark of specialisation, and in this respect also *Chanos* differs from both the Albulidæ and the Clupeidæ (except *Coilia*). The absence of a subtemporal fossa, which is present in the Elopidae and Albulidæ, but absent from the Clupeoid fishes, is an argument against Woodward's view; and again, the parietals meet one another in *Albula*, whereas in *Chanos* they are in reality separated by the supraoccipital, although a secondary union may be brought about by means of the commissural sensory-canal bones which fuse with the parietals.

Abbreviations employed in the Text-figures.

<i>af</i> , auditory fenestra.	<i>mx</i> , maxilla.
<i>al</i> , alisphenoid.	<i>n</i> , nasal.
<i>an</i> , angular.	<i>op</i> , opisthotic.
<i>ar</i> , articular.	<i>opc</i> , opercular.
<i>bb</i> , dentigerous plate covering the basibranchials.	<i>or</i> , orbitosphenoid.
<i>bo</i> , basioccipital.	<i>p</i> , parietal.
<i>br</i> , branchiostegal rays.	<i>pb</i> , pharyngobranchial.
<i>bs</i> , basisphenoid.	<i>pef</i> , pre-epiotic fossa.
<i>cb</i> , ceratobranchial.	<i>pl</i> , palatine.
<i>ch</i> , ceratohyal.	<i>pm</i> , premaxilla.
<i>cor</i> , circumorbital bones.	<i>pof</i> , postfrontal.
<i>ct</i> , cartilage.	<i>pop</i> , preopercular.
<i>d</i> , dentary.	<i>prf</i> , prefrontal.
<i>eb</i> , epibranchial.	<i>pro</i> , pro-otic.
<i>ecp</i> , ectopterygoid.	<i>ps</i> , parasphenoid.
<i>eh</i> , epihyal.	<i>pt</i> , post-temporal.
<i>enp</i> , entopterygoid.	<i>ptf</i> , posterior temporal fossa.
<i>eo</i> , exoccipital.	<i>q</i> , quadrate.
<i>ep</i> , epiotic.	<i>sar</i> , sesamoid articular.
<i>f</i> , frontal.	<i>sm</i> , surmaxilla.
<i>gh</i> , glossohyal.	<i>soc</i> , supraoccipital.
<i>hb</i> , hypobranchial.	<i>sop</i> , subopercular.
<i>hh</i> , hypohyal.	<i>sp</i> , spicular bone.
<i>hm</i> , hyomandibular.	<i>sq</i> , squamosal.
<i>ih</i> , interhyal.	<i>st</i> , supratemporal.
<i>iop</i> , interopercular.	<i>sy</i> , symplectic.
<i>me</i> , mesethmoid.	<i>tf</i> , temporal foramen.
<i>mpt</i> , metapterygoid.	<i>v</i> , vomer.

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GENERAL MEETINGS FOR SCIENTIFIC BUSINESS
OF THE
ZOOLOGICAL SOCIETY
OF LONDON.
1904, vol. II.

PART I.
CONTAINING PAPERS READ IN
MAY AND JUNE.

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PRINTED FOR THE SOCIETY,
SOLD AT THEIR HOUSE IN HANOVER SQUARE.

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THE ZOOLOGICAL SOCIETY OF LONDON.

THIS Society was founded in 1826 by Sir STAMFORD RAFFLES, Mr. J. SABINE, Mr. N. A. VIGORS, and other eminent Naturalists, for the advancement of Zoology and Animal Physiology, and for the introduction of new and curious subjects of the Animal Kingdom, and was incorporated by Royal Charter in 1829.

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P. CHALMERS MITCHELL, M.A., D.Sc.,
Secretary.

3 Hanover Square, London, W.,
October, 1904.

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OF THE
ZOOLOGICAL SOCIETY OF LONDON
FOR
SCIENTIFIC BUSINESS.
(AT 3 HANOVER SQUARE, W.)
Session 1904-1905.

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TUESDAY, NOVEMBER 15 and 29	TUESDAY, DECEMBER 13
1905.	
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„ FEBRUARY 7 and 21	„ MAY 2 and 16
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*The Chair will be taken at half-past Eight o'clock in the Evening
precisely.*

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OF THE

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THE scientific publications of the Zoological Society of London are of two kinds—"Proceedings," published in an octavo form, and "Transactions," in quarto.

According to the present arrangements, the "Proceedings" contain not only notices of all business transacted at the scientific meetings, but also all the papers read at such meetings and recommended to be published in the "Proceedings" by the Committee of Publication. A large number of coloured plates and engravings are attached to each annual volume of the "Proceedings," to illustrate the new or otherwise remarkable species of animals described in them. Amongst such illustrations, figures of the new or rare species acquired in a living state for the Society's Gardens are often given.

The "Proceedings" for each year are issued in four parts, on the first of the months of June, August, October, and April, the part published in April completing the volume for the last half of the preceding year. From January 1901 they have been issued as two half-yearly volumes.

The "Transactions" contain such of the more important communications made to the scientific meetings of the Society as, on account of the nature of the plates required to illustrate them, are better adapted for publication in the quarto form. They are issued at irregular intervals.

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[October, 1904.]

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P. CHALMERS MITCHELL,
Secretary.

October, 1904.

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ABSTRACT OF THE PROCEEDINGS
OF THE
ZOOLOGICAL SOCIETY OF LONDON.*

May 3rd, 1904.

G. A. BOULENGER, Esq., F.R.S., Vice-President, in the Chair.

The SECRETARY exhibited, on behalf of Dr. GRAHAM RENSHAW, F.Z.S., an outline sketch of a young African Elephant, mounted in the Museum of the Jardin des Plantes, Paris, which showed an unusual development of hairs on its body.

The SECRETARY also exhibited a photograph of the Quagga, taken by Mr. F. Haes from the last female specimen that had lived in the Gardens.

Mr. F. E. BEDDARD, F.R.S., exhibited the brain of a Troupial (*Quiscalus versicolor*) in the hinder part of both cerebral hemispheres of which was an entangled mass of Nematoid worms lying below the pia mater. The bird was reported to have dropped down suddenly from its perch "in a fit."

Mr. R. H. BURNE, F.Z.S., exhibited specimens of the female reproductive organs of *Perameles obesula*, *Trichosurus vulpecula*, and *Dasyurus viverrinus*; the specimens had been presented to the Museum of the Royal College of Surgeons by Professor Hill.

Mr. BURNE also exhibited photographs of the rare Leathery Turtle (*Dermochelys coriacea*).

Mr. OLDFIELD THOMAS, F.R.S., read a paper on the osteology and systematic position of the rare Malagasy Bat *Myzopoda aurita*. This Bat was considered to form a special family, the *Myzopodidae*, which appeared to be most nearly allied to the American *Natalidae* and *Mormopidae*.

* This Abstract is published by the Society at 3 Hanover Square, London, W., on the Tuesday following the date of Meeting to which it refers. It will be issued, free of extra charge, to all Fellows who subscribe to the Publications, along with the 'Proceedings'; but it may be obtained on the day of publication at the price of *Sixpence*, or, if desired, sent post-free for the sum of *Six Shillings* per annum, payable in advance.

Mr. F. E. BEDDARD, F.R.S., read a third of a series of papers on the Anatomy of the Lacertilia, which dealt with points in the vascular system of *Chamæleon* and other Lizards.

A communication from Mr. A. D. IMMS, B.Sc., contained notes on the gill-rakers of *Polydon*, in which he pointed out that these processes in this Fish were setiform structures disposed along both the anterior and posterior edges of the first four branchial arches and along the anterior edge of the fifth arch also. Each gill-raker consisted of a basal portion, which was attached by means of elastic fibres to the cartilage of the branchial arch, and a long, free shaft portion which formed its principal part. The matrix of a gill-raker contained numerous lacunar spaces which were connected with one another by means of canaliculi, and in the shaft portion it contained, in addition, a series of anastomosing channels in which lay blood-capillaries and some loose connective-tissue. The mucous membrane covering a branchial arch was prolonged over each gill-raker in the form of a complete investing coat. The gill-rakers of *Polydon* were exoskeletal structures, and they appeared to be composed of a substance closely allied to osteo-dentine, and their presence on the branchial arches might perhaps be accounted for on the supposition that the ectoderm forming the outer portions of the gill-clefts had migrated on to the inner margins of the branchial arches. The food of *Polydon* consisted of microscopical organisms, and the gill-rakers function as a straining mechanism which effectually barred the entry of such particles into the gill-cavities.

A paper was read by Dr. W. G. RIDWOOD, F.Z.S., on the "Cranial Osteology of the *Elopidae* and *Albulidae*, with Remarks on the Morphology of the Skull in the Lower Teleostean Fishes generally." The paper included a detailed account of the skulls of *Elops saurus*, *Megalops cyprinoides*, *Albula conorhynchus*, and *Bathyrhissa dorsalis*, together with remarks, generalisations, and criticisms of published accounts of the skull-bones of fishes, based mainly upon an examination of the skulls of 20 species of fishes selected from among the most primitive families of the existing Malacopterygii.

Among other features pointed out by Dr. Ridwood was the fact that in *Elops* and *Albula*, although the parietals met in the middle line, the supraoccipital extended forward beneath them to reach, and even to underlie, the frontal bones; in the former genus and in *Megalops* the supraoccipital also touched the alisphenoid bones. The posterior temporal fossæ were so great in *Megalops* that they reached the orbitosphenoid bone, and they communicated freely above the brain-case. A careful comparison of the skulls of *Bathyrhissa* and *Albula* confirmed the close relationship existing between these genera suggested by Boulenger in 1898. Except that in some few respects the bones were modified in correspondence with a deep-sea habit, the skull of *Bathyrhissa* bore a very close resemblance to that of *Albula*.

In the second part of the paper Dr. Ridewood discussed the relation of endosteal to ectosteal ossification, the eye-muscle canal, the various fossæ, fenestræ, and the larger foramina of the cranium, the bullæ enclosing vesicles of the swim-bladder, the union of a vertebral centrum with the back of the basicranial axis, the brush-like tendon-bones at the back of the skull (the opisthotic limb of the post-temporal was shown to belong to this series), the supratemporal and subtemporal bones, the sesamoid articular (so-called "coronoid"), the modes of articulation of the palatine and the hyomandibular bones with the cranium, the opercular bones, the hyobranchial skeleton, and the "spicular bone" (which Dr. Ridewood showed to be an ossified ligament, and not the first pharyngobranchial as had been previously supposed).

The next Meeting of the Society for Scientific Business will be held on Tuesday, the 17th May, 1904, at half-past Eight o'clock P.M., when the following communications will be made:—

1. Sir CHARLES ELIOT, K.C.M.G.—On some Nudibranchs from East Africa and Zanzibar.—Part V.

2. Mr. G. A. BOULENGER, F.R.S.—Description of a new Tree-Frog of the Genus *Hyla*, from British Guiana, carrying Eggs on the Back.

3. Mr. F. E. BEDDARD, F.R.S.—Notes upon the Anatomy of certain *Boidæ*.

The following Papers have been received:—

1. Dr. G. STEWARDSON BRADY, F.R.S., C.M.Z.S.—On Entomostrea collected in Natal by Mr. James Gibson.

2. Lt.-Col. J. MALCOLM FAWCETT.—On some new or little-known Butterflies, mainly from high elevations in the N.E. Himalayas.

3. Dr. P. CHALMERS MITCHELL.—On the Disposition and Morphology of the Intestinal Coils in Mammals.

Communications intended for the Scientific Meetings of the ZOOLOGICAL SOCIETY OF LONDON should be addressed to

P. CHALMERS MITCHELL, *Secretary*.

3 HANOVER SQUARE, LONDON, W.
10th May, 1904.

ABSTRACT OF THE PROCEEDINGS
OF THE
ZOOLOGICAL SOCIETY OF LONDON.*

May 17th, 1904.

HOWARD SAUNDERS, Esq., F.L.S., Vice-President, in the Chair.

The SECRETARY read a report on the additions that had been made to the Society's Menagerie during the month of April 1904, and called special attention to a fine specimen of the Boatbill (*Canchroma cochlearia*) obtained by purchase; to two Cheetahs (*Cynælurus jubatus*), from the Soudan, presented by Col. B. Mahon, C.B., F.Z.S.; and to two Keas (*Nestor notabilis*), presented by Mr. T. E. Doune.

Dr. W. T. CALMAN, F.Z.S., exhibited a specimen of a blind crustacean (*Munidopsis polymorpha*), from a subterranean lake in the island of Lanzarote, Canaries, collected by Mr. Fairfax Prevost. The species was described in 1892 by Dr. Koelbel, of Vienna, from specimens collected by Prof. Simony, but appears to have been overlooked by recent writers on the group to which it belongs. The lake in which it is found is salt and communicates with the sea, the water rising and falling with the tide. All the other species of the genus, over 100 in number, are inhabitants of the deep sea, none being recorded from a depth of less than about 100 fathoms.

Mr. F. E. BEDDARD, F.R.S., exhibited the body of an example of *Chlamydosaurus kingi* which had died in the Menagerie some years ago, and made remarks on the absence of femoral pores.

Mr. OLDFIELD THOMAS, F.R.S., exhibited, on behalf of the President, a sketch of a hind and fawn of Père David's Deer (*Elaphurus davidianus*) from Hainan.

* This Abstract is published by the Society at 3 Hanover Square, London, W., on the Tuesday following the date of Meeting to which it refers. It will be issued, free of extra charge, to all Fellows who subscribe to the Publications, along with the 'Proceedings'; but it may be obtained on the day of publication at the price of *Sixpence*, or, if desired, sent post-free for the sum of *Six Shillings* per annum, payable in advance.

The fifth of a series of papers by Sir CHARLES ELIOT, K.C.M.G., on Nudibranchs from Zanzibar and East Africa, was read. Twenty species of the genera *Notodoris*, *Trevelyana*, *Nembrotha*, *Marionia*, *Bornella*, and *Pleuroleura* were treated of in the paper, of which eleven were described as new.

Mr. G. A. BOULENGER, F.R.S., described a new species of Tree-Frog of the genus *Hyla*, from British Guiana, carrying eggs on the back.

Mr. F. E. BEDDARD, F.R.S., read a paper containing notes on the anatomy of certain species of Snakes of the family *Boidæ*.

A communication from Dr. G. STEWARDSON BRADY, F.R.S., C.M.Z.S., contained an account of a collection of Entomotraca made in Natal by Mr. James Gibson. Eleven species were enumerated in the paper, of which nine were described as new, one being made the type of a new genus.

The next Meeting of the Society for Scientific Business (closing the Session 1903-04) will be held on Tuesday, the 7th June, 1904, at half-past Eight o'clock P.M., when the following communications will be made:—

1. Lt.-Col. J. MALCOLM FAWCETT.—On some new or little-known Butterflies, mainly from high elevations in the N.E. Himalayas.

2. Dr. A. G. BUTLER, F.Z.S.—On Seasonal Phases in Butterflies.

3. Mr. F. E. BEDDARD, F.R.S.—Note on an apparently Abnormal Position of the “Brephos” within the body of a Skink (*Chalcides lineatus*).

4. Dr. E. A. GOELDI, C.M.Z.S.—On the rare Rodent *Dinomys branickii* Peters.

5. Mr. C. SATUNIN, C.M.Z.S.—On the Black Wild Cat of Transcaucasia.

6. Mr. R. LYDEKKER.—On a Buffalo Skull from East Central Africa.

7. Dr. A. SMITH WOODWARD, F.R.S.—On Two new Labyrinthodont Skulls.

Communications intended for the Scientific Meetings of the ZOOLOGICAL SOCIETY OF LONDON should be addressed to

P. CHALMERS MITCHELL, *Secretary*.

3 HANOVER SQUARE, LONDON, W.

24th May, 1904.

ABSTRACT OF THE PROCEEDINGS
OF THE
ZOOLOGICAL SOCIETY OF LONDON.

June 7th, 1904.

F. DuCANE GODMAN, Esq., D.C.L., F.R.S., Vice-President,
in the Chair.

The SECRETARY read a report on the additions—276 in number—that had been made to the Society's Menagerie during May 1904, and called special attention to the following specimens, all new to the collection:—Three Andaman Banded Crakes (*Rallina canningi*), presented by the Government of India; a Yellow-handed Howler (*Myctes beelzebul*), an Antilopine Kangaroo (*Macropus antilopinus*), and a Grey Solitaire (*Myiadectes unicolor*), deposited.

The SECRETARY also made some remarks on two fully-adult specimens of the Orang-Utan which he had recently seen in Paris.

Dr. GÜNTHER, F.R.S., Vice-Pres.Z.S., on behalf of the PRESIDENT, exhibited a series of hybrid Pheasants killed at various times in the coverts at Woburn, where many distinct species had been turned out into the open. He stated that nothing of a definite nature was known as to their parentage, but proposed tentative determinations.

Dr. F. D. DREWITT, F.Z.S., exhibited and made remarks upon two fine antlers of the North-African Red Deer (*Cervus elaphus barbarus*) which he had brought from the high forest land extending far inland on the borders of Tunis and Algeria.—Dr. DREWITT also exhibited a pair of horns of Loder's Gazelle (*Gazella leptoceros*) from South Algeria.

A communication from Dr. GRAHAM RENSHAW, F.Z.S., contained notes, illustrated by photographs, on a pair of Short-horned Buffaloes in the Antwerp Zoological Gardens.

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Mr. F. E. BEDDARD, F.R.S., exhibited and made remarks upon a skull of the Cape Crowned Crane (*Balearica chrysopelargus*) showing paired lateral and a single median bony bosses, suggestive of those of the horn-bearing vertebrates.

Mr. R. E. HOLDING exhibited and made remarks upon a series of 12 photographs of the horns of the Wapiti Stag living in the Society's Gardens, taken in fortnightly intervals from the shedding of the horns on March 30th, 1903, to the first week in October, when they were clear of velvet.—Mr. HOLDING also exhibited a fine pair of the shed horns of the Irish Red Deer, having 14 points and weighing 8 lbs.

Mr. R. I. Pocock, the Superintendent of the Gardens, exhibited and made remarks upon living specimens of hairless varieties of the Common House-Mouse (*Mus musculus*) and the Brown Rat (*M. decumanus*).—Mr. Pocock also exhibited and made remarks upon some young examples of the Egyptian Fat-tailed Gerbille (*Pachyuromys dupresi*), born in the Menagerie.

A communication from Lt.-Col. J. MALCOLM FAWCETT contained descriptions of ten species of Butterflies, mainly from high elevations in the N.E. Himalayas. Eight of them were new species or varieties and were diagnosed as follows:—

MELITÆA TIBETANA, sp. n.

Hab. Khamba Jong, Thibet, 15,000 ft. elevation.

Allied to the var. of *M. sindura* Moore (described by Elwes in Trans. Ent. Soc. 1888, pt. iii. p. 336), which = *M. sikkimensis* Moore, but differs from it in its much paler coloration, and the presence on the upperside of pale ochreous bands and spots, and more prominent fuscous markings.

ARGYNNIS CLAUDIA, sp. n.

Hab. Khamba Jong, Thibet, 15,000 ft. elevation.

Allied to *A. clara* Blanchard, but differs from it in its rounder wings, smaller size, and paler coloration on upperside; the outer margins of both wings are broadly fuscous, containing a submarginal series of pale spots, *without* the submarginal and marginal fine black lines beyond them as in *A. clara*.

LYCÆNA ARIANA Moore, var. ARENE, var. n.

Hab. Khamba Jong, Thibet, 15,000 ft. elevation.

Differs from *L. ariana* Moore, from the N.W. Himalaya, in being smaller, and in the discal row of black spots on the underside being minute, fewer in number, and obsolete in some specimens in the hind wing, and in the discal white spots at apex of cell of hind wing being larger.

LYCÆNA PHERETES Hübner, var. PHARIS, var. n.

Hab. Khamba Jong, Thibet, 15,000 ft. elevation.

This form differs from the var. *asiatica* of Elwes in having fewer discal black spots on fore wing, and in the size and length of the pale cellular spot on hind wing underside.

LYCÆNA (ZIZERA) ZERA, sp. n.

Hab. Tounghoo, Burma (June).

Nearly allied to *L. (Z.) marginata* from China, but differs in the discal row of fuscous spots of the fore wing being fainter and more regular on the underside, and in the black border of the upperside being more even in its inner edge and bending inwards on the costa.

LYCÆNA (NIPHANDA) MARCIA, sp. n.

Hab. Tounghoo, Burma (June).

Allied to *N. tessellata* Moore, from Penang, but differs in its much less heavy markings on the underside.

COLIAS BERYLLA, sp. n.

Hab. Khamba Jong, Thibet, 15,000 ft. elevation.

This species belongs to the *C. hyale* section of *Colias*, and is nearest to *C. erschoffi* Alphéraky, from Thian Shan Mts., but differs in the greater melanism of hind wing.

COLIAS NINA, sp. n.

Hab. Khamba Jong, Thibet, 15,000 feet elevation.

This species appears to be a transition between the *C. hyale* and *C. edusa* sections of *Colias*.

Dr. A. G. BUTLER, F.Z.S., contributed a paper "On Seasonal Phases in Butterflies," in which he stated that so-called "seasonal forms" were only the variations of polymorphic species adapted to seasons, by the gradual elimination of those varieties which were unsuited to the environment of those seasons. This adaptation being incomplete in the case of many species, it was absurd to express astonishment if forms characteristic of the wet and dry seasons sometimes appeared simultaneously. Because they did sometimes appear together, the author had some years since proposed the term "seasonal phase" to supersede that of "seasonal form."

Capt. RICHARD CRAWSHAY, F.Z.S., contributed a note on the Prey of the Lion, showing that the popular belief of the Lion being a fastidious feeder was incorrect, but that he ate carrion not killed by himself in all stages of putrefaction, and was not averse to preying on such very small game as the smaller rodents. The tips of a Porcupine's quills found buried in a Lion's fore paw were exhibited, together with the skull and complete skin of the Lion.

Attention was drawn to the filthy state of this Lion's claws, which enabled it to be realised how it was that septic poisoning so often terminated fatally with persons mauled by Lions.

Mr. F. E. BEDDARD, F.R.S., read the following three papers based on observations he had made in the Society's Prosectorium: (1) "Note on an apparently Abnormal Position of the 'Brepheos' within the Body of a Skink (*Chalcides lineatus*)"; (2) "Contributions to the Knowledge of the Visceral Anatomy of the Pelagic Serpents *Hydrus platyurus* and *Platyurus columbinus*"; and (3) "On the Presence of a Parasternum in the Lacertilian Genus *Triliqua* and on the Poststernal Ribs in that Genus."

A communication from Dr. E. A. GOELDI, C.M.Z.S., contained a description and an account of the habits of the rare Rodent *Dinomys branickii* Peters, living specimens of which had recently been received at the Goeldi Museum, Pará. Dr. Goeldi was uncertain as to the exact habitat of this animal, but he was of opinion that it was in the almost unexplored regions of the eastern slopes and tablelands of Bolivia and Peru bordering on Brazil.

A communication from Dr. C. SATUNIN, C.M.Z.S., contained an account of the Black Wild Cat of Transcaucasia, which he described as a new species.

Mr. R. LYDEKKER, F.Z.S., described the skull of a Buffalo from East Central Africa as the type of a new race, with the name *Bos caffer matthewsi*. This Buffalo appeared to connect the typical *B. caffer* with *B. c. nanus*, having horns approaching those of the latter, but its skin and hair black. A white tip to the tail seemed a special peculiarity.

Mr. LYDEKKER also described from Ichang a new species of Tufted Deer (*Elaphodus ichangensis*) differing from *E. michianus* in its darker colour, whiter tail, smaller antlers, longer tusks, shorter nasals, and certain other features in the skull.

Dr. A. SMITH WOODWARD, F.R.S., read a paper on two new Labyrinthodont skulls acquired by the British Museum. They were the skull of a new species of *Capitosaurus* from the Trias of N. Staffordshire, which showed the occiput more clearly than any Labyrinthodont skull hitherto described, and demonstrated its Amphibian character; and the skull of a new genus allied to *Trematosaurus*, from the Trias of Spitzbergen, which was the first satisfactory Labyrinthodont fossil described from the Arctic Regions.

This Meeting closes the Session 1903-04. The next Session (1904-05) begins in November.

Communications intended for the Scientific Meetings of the ZOOLOGICAL SOCIETY OF LONDON should be addressed to

P. CHALMERS MITCHELL, *Secretary*.

3 HANOVER SQUARE, LONDON, W.

14th June, 1904.

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NOTICE.

The 'Proceedings' for the year are issued in *four* parts, forming two volumes, as follows:—

VOL. I.

Part I. containing papers read in January and February, in June.

II. " " " " March and April, in August.

VOL. II.

Part I. containing papers read in May and June, in October.

II. " " " " November and December, in April.

'Proceedings,' 1904, Vol. I. Part II. was published on August 2nd, 1904.

The Abstracts of the papers read at the Scientific Meetings in May and June are contained in this Part.

PROCEEDINGS
OF THE
GENERAL MEETINGS FOR SCIENTIFIC BUSINESS
OF THE
ZOOLOGICAL SOCIETY
OF LONDON.
1904, vol. II.

PART II.
CONTAINING PAPERS READ IN
NOVEMBER AND DECEMBER.

APRIL 1905.

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THE ZOOLOGICAL SOCIETY OF LONDON.

THIS Society was founded in 1826 by Sir STAMFORD RAFFLES, Mr. J. SABINE, Mr. N. A. VIGORS, and other eminent Naturalists, for the advancement of Zoology and Animal Physiology, and for the introduction of new and curious subjects of the Animal Kingdom, and was incorporated by Royal Charter in 1829.

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The Society consists of Fellows, and Honorary, Foreign, and Corresponding Members, elected according to the By-Laws.

The Gardens in the Regent's Park are open from Nine o'clock A.M. till Sunset.

The Offices (3 Hanover Square, W.), where all communications should be addressed, are open from Ten till Five, except on Saturdays, when they are closed at Two o'clock P.M.

The Library (3 Hanover Square), under the superintendence of Mr. F. H. WATERHOUSE, Librarian, is open from 10 A.M. to 5 P.M., on Saturdays to 2 P.M. It is closed in the month of September.

The Meetings of the Society for General Business are held at the Office on the Thursday following the third Wednesday in every month of the year, except in September and October, at Four P.M.

The Meetings for Scientific Business are held at the Office twice a month on Tuesdays, except in July, August, September, and October, at half-past Eight o'clock P.M.

The Anniversary Meeting is held on the 29th April, at Four P.M., or the nearest convenient day (April 28, 1905).

TERMS FOR THE ADMISSION OF FELLOWS.

FELLOWS pay an Admission Fee of £5, and an annual Contribution of £3, due on the 1st of January, and payable in advance, or a Composition of £30 in lieu thereof; the whole payment, including the Admission Fee, being £35.

No person can become a FELLOW until his Admission Fee and First Annual Subscription have been paid, or the annual payments have been compounded for.

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Any FELLOW who intends to be absent from the United Kingdom during the space of one year or more may, upon giving to the Secretary notice in *writing*, have his name placed upon the "dormant list," and will be thereupon exempt from the payment of his annual contribution during such absence.

Any FELLOW, having paid all fees due to the Society, is at liberty to withdraw his name upon giving notice in *writing* to the Secretary.

Ladies or Gentlemen wishing to become Fellows of the Society are requested to communicate with the undersigned.

P. CHALMERS MITCHELL, M.A., D.Sc.,

Secretary.

3 Hanover Square, London, W.,

April, 1905.

MEETINGS
OF THE
ZOOLOGICAL SOCIETY OF LONDON
FOR
SCIENTIFIC BUSINESS.
(AT 3 HANOVER SQUARE, W.)
Session 1904-1905.

1904.

TUESDAY, NOVEMBER 15 and 29 | TUESDAY, DECEMBER 13

1905.

TUESDAY, JANUARY 17 „ FEBRUARY 7 and 21 „ MARCH .. 7 „ 21	|	TUESDAY, APRIL .. 18 „ MAY 2 and 16 „ JUNE 6
-----------------------------------------------------------------	--	--------------------------------------------------------------

*The Chair will be taken at half-past Eight o'clock in the Evening
precisely.*

LIST OF THE PUBLICATIONS

OF THE

ZOOLOGICAL SOCIETY OF LONDON.

THE scientific publications of the Zoological Society of London are of two kinds—"Proceedings," published in an octavo form, and "Transactions," in quarto.

According to the present arrangements, the "Proceedings" contain not only notices of all business transacted at the scientific meetings, but also all the papers read at such meetings and recommended to be published in the "Proceedings" by the Committee of Publication. A large number of coloured plates and engravings are attached to each annual volume of the "Proceedings," to illustrate the new or otherwise remarkable species of animals described in them. Amongst such illustrations, figures of the new or rare species acquired in a living state for the Society's Gardens are often given.

The "Proceedings" for each year are issued in four parts, on the first of the months of June, August, October, and April, the part published in April completing the volume for the last half of the preceding year. From January 1901 they have been issued as two half-yearly volumes.

The "Transactions" contain such of the more important communications made to the scientific meetings of the Society as, on account of the nature of the plates required to illustrate them, are better adapted for publication in the quarto form. They are issued at irregular intervals.

Fellows and Corresponding Members, upon payment of a Subscription of One Guinea *before* the day of the Anniversary Meeting in each year, are entitled to receive the Society's Publications for the year. They are likewise entitled to purchase the Publications of the Society at 25 per cent. less than the price charged for them to the Public. A further reduction of 25 per cent. is made upon purchases of Publications issued prior to 1881, if they exceed the value of five pounds.

Fellows also have the privilege of subscribing to the Annual Volume of the Zoological Record for a sum of £1 (which includes delivery in the United Kingdom *only*), payable on the 1st July in each year; but this privilege is forfeited unless the subscription be paid *before* the 1st of December following.

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[April, 1905.]

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P. CHALMERS MITCHELL,

Secretary.

April, 1905.

ZOOLOGICAL SOCIETY OF LONDON,
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Index Zoologicus. An alphabetical list of names of genera and subgenera proposed for use in Zoology, as recorded in the Zoological Record, 1880-1900; together with other names not included in the 'Nomenclator zoologicus' of S. H. Scudder. Compiled (for the Zoological Society of London) by CHARLES OWEN WATERHOUSE and edited by DAVID SHARP, Editor of the Zoological Record. London, 1902. Price to Fellows, 18s.; price to the public, 20s.

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ABSTRACT OF THE PROCEEDINGS
OF THE
ZOOLOGICAL SOCIETY OF LONDON.*

November 15th, 1904.

Dr. W. T. BLANFORD, C.I.E., F.R.S., Vice-President,
in the Chair.

The SECRETARY read a report on the additions that had been made to the Society's Menagerie during the months of June, July, August, September, and October, 1904. Amongst these several were of great interest.

Prof. J. C. EWART, F.R.S., exhibited some skins and a series of lantern-slides of Zebras from East Africa. He pointed out that a variety of Crawshay's Zebra occurred in East Africa in the vicinity of Lake Nakuru. The East African variety differed from the typical Crawshay's Zebra of British Central Africa mainly in having fewer vertical body-stripes. Prof. Ewart also pointed out that, in addition to the Grant and Crawshay varieties, East Africa had a Zebra which, in certain points, resembled the Common or Mountain Zebra of South Africa. This new Zebra had, like the Mountain Zebra, very long ears, a short mane, a well-marked gridiron over the croup, and narrow hoofs. It differed from the true Mountain Zebra in having a broad dorsal band and very decidedly smaller chestnuts.

Mr. R. LYDEKKER, F.R.S., communicated the fact that the sketch exhibited to the Society last Session as that of a Père David's Deer from Hainan was drawn by the artist from memory and not direct from a specimen, and it could, therefore, not be taken as evidence of the occurrence of this Deer in that country.

Mr. F. E. BEDDARD, F.R.S., described the sound emitted by a young Kangaroo that had been found in its dead mother's pouch.

Mr. FREDERICK GILLET, F.Z.S., exhibited some antlers of the Altai Stag (*Cervus eustephanus*), and made remarks upon their growth as observed by him in the Society's Gardens.

* This Abstract is published by the Society at 3 Hanover Square, London, W., on the Tuesday following the date of Meeting to which it refers. It will be issued, free of extra charge, to all Fellows who subscribe to the Publications, along with the 'Proceedings'; but it may be obtained on the day of publication at the price of *Sixpence*, or, if desired, sent post-free for the sum of *Six Shillings* per annum, payable in advance.

Dr. P. L. SCLATER, F.R.S., made some remarks on the specimens of the Okapi lately inspected by him in the Congo Free State Museum, at Tervueren, near Brussels.

Mr. W. B. TEGETMEIER, F.Z.S., exhibited a specimen of the Asiatic King Crab which had been discovered in a living condition off the Isle of Wight.

Mr. OLDFIELD THOMAS, F.R.S., read a paper on the Mammals obtained in the island of Fernando Po by Mr. E. Seimund during an expedition supported by the Society's President (the Duke of Bedford), Mrs. Percy Sladen, and the Hon. Walter Rothschild. Twenty-four species were enumerated, and the two following new subspecies were described:—

GALAGO DEMIDOFFI POENSIS, subsp. n.

Similar to true *G. demidoffi*, but the under surface much paler, and the inner faces of the limbs pure white. Size as in the typical form.

Hab. Bantabiri, Fernando Po, alt. 1800 m.

Type. B.M. no. 4. 7. 1. 8.

ANOMALURUS FRASERI NIGRENSIS, subsp. n.

Similar to true *A. fraseri*, but size smaller and colour paler.

Length of hind foot 57 mm. Skull: tip of nasals to back of parietals 53 mm.; length of upper tooth series 11.9 mm.

Hab. Abutschi, Lower Niger.

Type. B.M. no. 2. 11. 10. 5.

A special genus, *Sylvisorex*, with type *S. morio*, Gray, was formed to include the Shrews hitherto put with *M. varius* in *Myosorex*, and another, *Mimetillus*, for the Bat described as *Vesperugo* (*Vesperus*) *moloneyi* Thos.

A list was appended of the Mammals, 36 in number, now known to inhabit the island.

Mr. OLDFIELD THOMAS also read a paper, entitled "On *Hylochaerus*, the Forest-Pig of Central Africa," and exhibited the skulls and portions of skin of this animal obtained by Mr. R. Meinertzhagen in the Nandi Forest, British East Africa.

This Pig had been heard of by the late Sir H. Stanley, Sir H. H. Johnston, Mr. F. J. Jackson, and other naturalists, but Mr. Meinertzhagen was the first to obtain specimens of it, and these he had presented to the National Museum.

Hylochaerus meinerzhageni, as it was proposed to be called, proved to be a remarkably interesting type, annectant in many respects between the ordinary Pigs and the Wart-Hog (*Phacochoerus*), to which latter on the whole it was most nearly allied. It agreed with that genus in the number of its incisors, the presence of large basisphenoid pits, the great thickness of the upper canines (though not their length), and in the direction and shape of the lower ones. Its molars were not hypsodont, but were of a type very different to that found in *Sus*, and one from which the peculiar hypsodont molars of *Phacochoerus* might conceivably have been evolved.

The general shape of the skull was more normal than in *Phacochoerus*, while in the breadth of the crown there was a peculiar

resemblance to the *Sus erymanthius* of the Pikermi beds, though in its tooth-structure this latter animal was a typical *Sus*.

Hylochaerus showed no relationship to *Potamochaerus* either in the structure of the nasal region or the character of the lower canines, these being of the more primitive shape found in *Phacochoerus* and the *Sus verrucosus* group, while in *Potamochaerus* they were of the more specialized type characteristic of *Sus scrofa* and its allies.

Dr. P. CHALMERS MITCHELL read a paper on the African Crowned Cranes, giving notes on the distribution and characters of the species. He recorded the extension of the range of the Cape form, *Balearica regulorum*, to Kavirondo, in Uganda, and he described as new a species founded on specimens obtained by Lady William Cecil at Khartoum and presented to the Society's Gardens:—

BALEARICA CECILIE, sp. nov.

Similar to *B. pavonina*, and hitherto confused with it. Smaller and darker, beak shorter and black to the tip; cheek-patch red below, white above, but the white area very small.

Mr. J. LEWIS BONHOTE, F.Z.S., read a paper on the "Mouse-Hares" of the genus *Ochotona* inhabiting the Palearctic Region. It was pointed out that the various species might be easily divided into three divisions, from a study of their skulls, the differences lying chiefly in the incisive and palatal foramina. In the first of these, the *Ladacensis* group, the two sets of foramina were entirely separated by the bony palate; in the next division, called the *Rufescens* group, there was only one large foramen slightly constricted in the centre; and in the last division, called the *Curzonie* group, the large foramen was triangular in shape. The paper dealt fully with the various species, their seasonal changes, and distribution. One new species belonging to the *Rufescens* group was described under the name *O. wardi*, after Col. A. E. Ward, who had collected it in Kashmir. It was of moderate size, and of a uniform iron-grey in winter, becoming red, especially about the head and neck, in summer. Since the paper was written, Mr. Lyon, jun., in a paper on the whole of the Duplicidentia, subdivided the genus *Ochotona* into three subgenera, viz. *Ochotona*, *Conothoa*, and *Pika*; these subgenera coincided with the three groups mentioned above, viz. *Curzonie*, *Rufescens*, and *Ladacensis* respectively.

A communication from Prof. W. BLAXLAND BENHAM, F.Z.S., contained descriptions of twelve new species of Earthworms from the North Island of New Zealand.

The next Meeting of the Society for Scientific Business will be held on Tuesday, the 29th November, 1904, at half-past Eight o'clock P.M., when the following communications will be made:—

1. Capt. RICHARD CRAWSHAY, F.Z.S.—Some Observations on the Field Natural History of the Lion.
2. Sir CHARLES ELIOT, K.C.M.G.—On some Nudibranchs from East Africa and Zanzibar.—Part VI.

3. Mr. R. LYDEKKER, F.R.S.—The Altai Lynx.
4. Mr. R. LYDEKKER, F.R.S.—On old Pictures of Giraffes and Zebras.
5. Dr. H. J. HANSEN.—On the Morphology and Classification of the *Asellota* Group of Crustaceans, with Descriptions of the Genus *Stenetrium* and its Species.
6. Mr. G. A. BOULENGER, F.R.S.—On the *Lacerta depressa* of Camerano.

The following papers have been received :—

1. Mr. ROBERT GURNEY, F.Z.S.—On a small Collection of Freshwater Entomotraca from South Africa.
2. Mr. W. F. LANCHESTER, M.A.—On a Collection of Sipunculids made at Singapore and Malacca.
3. Mr. W. F. LANCHESTER, M.A.—On a Collection of *Gephyrea* from Zanzibar.
4. Mr. W. F. LANCHESTER, M.A.—On the Sipunculids and Echiurids collected during the "Skeat Expedition" to the Malay Peninsula.
5. Mr. R. LYDEKKER, F.R.S.—On two Lorises.
6. Mr. PERCY I. LATHY, F.Z.S.—Descriptions of new Species of Peruvian Rhopalocera.
7. Mr. A. D. IMMS, B.Sc.—On the Oral and Pharyngeal Denticles of Elasmobranchs.
8. Dr. W. T. BLANFORD, C.I.E., F.R.S.—Descriptions of Indian and Burmese Land-Shells referred to the Genera *Macrochlamys*, *Bensonina*, *Taphrospira* (gen. nov.), *Microcystina*, *Euplecta*, and *Polita*.
9. Mr. F. E. BEDDARD, F.R.S.—Some Notes on the Cranial Osteology of *Uromastix*.
10. Mr. F. E. BEDDARD, F.R.S.—On the Deaths in the Menagerie from January to June, 1904.
11. Dr. W. G. RIDEWOOD, F.Z.S.—On the Cranial Osteology of the Clupeoid Fishes.
12. Mr. MARTIN A. C. HINTON.—On some Abnormal Remains of *Cervus elaphus* from the Post-Pliocene Deposits of the South of England.
13. Prof. E. A. MINCHIN, F.Z.S. — The Characters and Synonymy of the British Species of *Leucosolenia*.

Communications intended for the Scientific Meetings of the ZOOLOGICAL SOCIETY OF LONDON should be addressed to

P. CHALMERS MITCHELL, *Secretary*

3 HANOVER SQUARE, LONDON, W
22nd November, 1904.

ABSTRACT OF THE PROCEEDINGS
OF THE
ZOOLOGICAL SOCIETY OF LONDON.*

November 29th, 1904.

G. A. BOULENGER, Esq., F.R.S., Vice-President, in the Chair.

Dr. WALTER KIDD, F.Z.S., exhibited a drawing of, and made some remarks upon, the extensor surface of the hand of a Chimpanzee.

A communication was read from Capt. RICHARD CRAWSHAY, F.Z.S., containing some observations on the field Natural History of the Lion made during 17 years of travel and residence in Central Africa.

The sixth part of Sir CHARLES ELIOT'S contributions "On some Nudibranchs from East Africa and Zanzibar" was read. It contained an account of thirty species and varieties, of which eight of the former and one of the latter were described as new.

Mr. R. LYDEKKER exhibited and read a paper on some photographs of Giraffes and a Zebra taken from pictures in the Art Collection at Windsor Castle, and an old print of a Zebra dated 1762. Mr. Lydekker was of opinion that the picture and print of the Zebra had been taken from the same animal.

In a second communication Mr. LYDEKKER described two specimens of Lorises, one a Slow Loris (*Nycticebus*) and the other a Slender Loris (*Loris*), which had recently been acquired by the British Museum. The latter was pointed out to be sufficiently different from the typical *L. gracilis* to be entitled to subspecific rank.

* This Abstract is published by the Society at 3 Hanover Square, London, W., on the Tuesday following the date of Meeting to which it refers. It will be issued, free of extra charge, to all Fellows who subscribe to the Publications, along with the 'Proceedings'; but it may be obtained on the day of publication at the price of *Sixpence*, or, if desired, sent post-free for the sum of *Six Shillings* per annum, payable in advance.

A paper was read from Dr. H. J. HANSEN, of Copenhagen, dealing with the Morphology and Classification of the *Asellota* group of Crustaceans, and giving descriptions of the genus *Stenotrium* and its species.

Mr. G. A. BOULENGER, F.R.S., V.P., read a paper on the Lizard *Lacerta depressa* of Camerano and its varieties.

A communication from Mr. ROBERT GURNEY, F.Z.S., giving an account of a small collection of Freshwater Entomostraca from South Africa, was read. The collection comprised examples of five species, three of which were described as new.

Mr. F. E. BEDDARD, F.R.S., read a paper on the Cranial Osteology of the Egyptian Mastigure (*Uromastix spinipes*), based on observations made in the Society's Prosectorium.

The next Meeting of the Society for Scientific Business will be held on Tuesday, the 13th of December, 1904, at half-past Eight o'clock P.M., when the following communications will be made:—

1. The Hon. WALTER ROTHSCHILD, M.P., F.Z.S.—Some Notes on Anthropoid Apes.

2. Dr. W. G. RIDWOOD, F.Z.S.—On the Cranial Osteology of the Clupeoid Fishes.

3. Prof. E. A. MINCHIN, F.Z.S.—The Characters and Synonymy of the British Species of *Leucosolenia*.

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1. Mr. W. F. LANCHESTER, M.A.—On a Collection of Sipunculids made at Singapore and Malacca.

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3. Mr. W. F. LANCHESTER, M.A.—On the Sipunculids and Echiurids collected during the "Skeat Expedition" to the Malay Peninsula.

4. Mr. PERCY I. LATHY, F.Z.S.—Descriptions of new Species of Peruvian Rhopalocera.

5. Mr. A. D. IMMS, B.Sc.—On the Oral and Pharyngeal Denticles of Elasmobranchs.

6. Dr. W. T. BLANFORD, C.I.E., F.R.S.—Descriptions of Indian and Burmese Land-Shells referred to the Genera *Macrochlamys*, *Bensonia*, *Taphrospira* (gen. nov.), *Microcystina*, *Euplecta*, and *Polita*.

7. Mr. MARTIN A. C. HINTON.—On some Abnormal Remains of *Cervus elaphus* from the Post-Pliocene Deposits of the South of England.

8. Mr. G. A. BOULENGER, F.R.S.—A Contribution to our Knowledge of the Varieties of *Lacerta muralis* in Western Europe and North Africa.

9. Mr. M. JACOBY.—Descriptions of Thirty-two new Species of *Halticinae* (Phytophagous Coleoptera) from South and Central America.

10. Mr. G. T. BETHUNE BAKER.—Notes on a small Collection of Heterocera from the Fiji Islands, with Descriptions of some new Species.

11. Mr. F. E. BEDDARD, F.R.S.—A Contribution to the Anatomy of *Chlamydosaurus* and some other *Agamidae*.

12. Mr. F. E. BEDDARD, F.R.S.—A Note on the Brain of *Cynopithecus niger*.

Communications intended for the Scientific Meetings of the ZOOLOGICAL SOCIETY OF LONDON should be addressed to

P. CHALMERS MITCHELL, *Secretary*.

3 HANOVER SQUARE, LONDON, W.

6th December, 1904.

ABSTRACT OF THE PROCEEDINGS
OF THE
ZOOLOGICAL SOCIETY OF LONDON.*

December 13th, 1904.

HERBERT DRUCE, Esq., F.L.S., Vice-President, in the Chair.

The SECRETARY read a report on the additions that had been made to the Society's Menagerie during November 1904, and called special attention to a Ferret-Badger (*Helictis personata*) from Burmah; to two Chimpanzees (*Anthropopithecus schweinfurthi*) from the Bagomo Forest, Uganda; to a male specimen of the Senegal race of the African Buffalo (*Bubalus centralis*); and to three Mouse-Hares (*Ochotona roylei*) from Baluchistan. The total number of additions during the month was 150.

Mr. OLDFIELD THOMAS, F.R.S., exhibited specimens of a pair of Gazelles from Jerusalem which had been obtained and presented to the British Museum by Dr. Selah Merrill. They represented a new species allied to the Atlas Gazelle, and were proposed to be named

GAZELLA MERRILLI, sp. n.

Allied to *G. cuvieri*, but smaller, with shorter horns, these being more strongly curved backwards below and recurved forwards at their tips. Premaxillæ not reaching nasals.

Extreme length of the typical male skull 194 mm.; horn, length over curves anteriorly 241.

Hab. Hizmeh, N. of Jerusalem.

The Hon. WALTER ROTHSCHILD, Ph.D., F.Z.S., read a paper on Anthropoid Apes. He characterised four forms of Gorilla (*Gorilla*), twelve of Chimpanzee (*Simia*), and four of Orang-Utan (*Pongo*),

* This Abstract is published by the Society at 3 Hanover Square, London, W., on the Tuesday following the date of Meeting to which it refers. It will be issued, free of extra charge, to all Fellows who subscribe to the Publications, along with the 'Proceedings'; but it may be obtained on the day of publication at the price of *Sixpence*, or, if desired, sent post-free for the sum of *Six Shillings* per annum, payable in advance.

each of the last with a dimorphic phase. Of these the South Cameroon race of *Gorilla gorilla* and the Gaboon White-faced Chimpanzee were described as new. In illustration of the paper Mr. Rothschild exhibited seven stuffed Gorillas, eight stuffed Chimpanzees, twenty-six skulls of Gorillas, two skulls of Chimpanzees, two entire skeletons of Gorillas, some casts of a Gorilla and Gorilla skulls, a number of photographs and drawings of Chimpanzees, and two drawings of Orang-Utans. The bulk of the mounted specimens, all but three Gorillas and two Chimpanzees, were mounted under Mr. Rothschild's personal supervision, from photographs and sketches from life, by Rowland Ward; the five exceptions were set up by Gerrard.

Dr. W. G. RIDEWOOD, F.Z.S., read a paper on the Cranial Osteology of the Clupeoid Fishes, a sequel to two papers dealing with the skull in the Elopoid and Mormyroid Fishes which had already been published. The skulls of *Chanos*, *Chirocentrus*, *Chatoëssus*, *Clupea*, and seven other genera were described in greater or less detail, and in a Summary the relative values of such "Clupeoid" characters as the temporal foramen, auditory fenestra, pre-epiotic fossa, pro-otic and squamosal bullæ, and posterior wings of the parasphenoid bone were discussed. Dr. Ridewood arrived at the conclusion that *Chanos* had no close affinity with the Clupeidæ; and he pointed out that the skull of *Chirocentrus* so closely resembled that of the Clupeidæ that it was only the strongly marked differences to be found in other parts of the body which justified the retention of the Chirocentridæ as a family distinct from the Clupeidæ.

Professor E. A. MINCHIN, F.Z.S., read a paper on the characters and synonymy of the British species of Sponges of the genus *Leucosolenia*, based on examination of the type specimens in the British Museum and elsewhere. Three species were recognised, namely:—*L. botryoides* (Ell. & Sol.), synonyms *Ascandra botrys* Hæckel and *A. nitida* H.; *L. complicata* (Mont.), synonyms *Ascandra pinus* H., *Ascortis fabricii* H., *Asculmis armata* H., and possibly *Ascyssa acufera* H.; and *L. variabilis* H., synonyms *Ascortis corallorrhiza* H., *Ascandra tenuis* Schuffner, and *Leuconia somesii* Bowerbank. The paper aimed at giving an exhaustive account of the characters and variations of the three species.

Dr. W. T. BLANFORD, C.I.E., F.R.S., read a paper containing descriptions of 18 species of Land-Mollusca belonging to the genus *Macrochlamys* and its allies. All were from the British Indian Empire, and about half were collected by the describer; some were from Colonel Beddome's or other collections. Of the species described, twelve were referred to *Macrochlamys*, one to *Taphrospira* (nov. gen., type *Helix convallata* Benson), one to *Bensonia*, one to *Polita*, two to *Microcystina*, and one to *Euplecta*.

A communication from Mr. MARTIN JACOBY contained descriptions of a new genus and thirty-two new species of Phytophagous Coleoptera of the family Halticidæ from South and Central America.

The next Meeting of the Society for Scientific Business will be held on Tuesday, the 17th January, 1905, at half-past Eight o'clock P.M., when the following communications will be made:—

1. Mr. W. F. LANCHESTER, M.A.—On a Collection of Sipunculids made at Singapore and Malacca.

2. Mr. W. F. LANCHESTER, M.A.—On a Collection of *Gephyrea* from Zanzibar.

3. Mr. W. F. LANCHESTER, M.A.—On the Sipunculids and Echiurids collected during the "Skeat Expedition" to the Malay Peninsula.

4. Mr. A. D. IMMS, B.Sc.—On the Oral and Pharyngeal Denticles of Elasmobranchs.

5. Mr. F. E. BEDDARD, F.R.S.—A Contribution to the Anatomy of *Chlamydosaurus* and some other *Agamidae*.

6. Mr. F. E. BEDDARD, F.R.S.—A Note on the Brain of *Cynopithecus niger*.

The following Papers have been received:—

1. Mr. PERCY I. LATHY, F.Z.S.—Descriptions of new Species of Peruvian Rhopalocera.

2. Mr. MARTIN A. C. HINTON.—On some Abnormal Remains of *Cervus elaphus* from the Post-Pliocene Deposits of the South of England.

3. Mr. G. A. BOULENGER, F.R.S.—A Contribution to our Knowledge of the Varieties of *Lacerta muralis* in Western Europe and North Africa.

4. Mr. G. T. BETHUNE BAKER, F.Z.S.—Notes on a small Collection of Heterocera from the Fiji Islands, with Descriptions of some new Species.

5. Mr. F. E. BEDDARD, F.R.S.—Some Notes on the Cranial Osteology of *Uromastix*.

Communications intended for the Scientific Meetings of the ZOOLOGICAL SOCIETY OF LONDON should be addressed to

P. CHALMERS MITCHELL, *Secretary*.

3 HANOVER SQUARE, LONDON, W.
20th December, 1904.

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NOTICE.

The 'Proceedings' for the year are issued in *four* parts, forming two volumes, as follows:—

VOL. I.

- Part I. containing papers read in January and February, in June.
 II. " " " " March and April, in August.

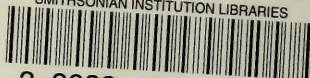
VOL. II.

- Part I. containing papers read in May and June, in October.
 II. " " " " November and December, in April.

'Proceedings,' 1904, Vol. II. Part I. was published on October 1st, 1904.

The Abstracts of the papers read at the Scientific Meetings in November and December are contained in this Part.

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